# Introduction: A Meeting of Hearts, Minds, and Microbiomes

At its core, this book is a treatise on the interconnectivity of all life, so before we begin we want to share how we have become interconnected in our purpose and our life together. We also take this as an opportunity for each of us to introduce the other.

The cold edges of winter were slowly setting underfoot. The magnificence of Mount Fuji rose above us, a small group of strangers standing on a lakeshore at the side of a Japanese highway. Lost in translation. Waiting to reboard our bus. Not knowing where life was about to take us. Not knowing we would be changed for ever. Anticipation was in the air, our awareness heightened by nature. A strangeness of knowing. But not of what. We were on the edge of a journey that would take decades to unfold. This moment was one we would never forget. As our eyes locked that first time, our destinies became entwined. We felt the future before any words were spoken. A strong and powerful force was at play, its shape, yet to be revealed, one of deep connection that would later shape the rest of our lives. That was the beginning of our calling together. One that had started for each of us long before, but that would one day become united.

From that moment in November, 2003, our purpose together was set. We may have been part of a small delegation that arrived in Japan to discuss probiotics and therapeutic opportunities for bacteria in human health, but our first conversations were shaped by a much wider, much broader shared vision. We had come from opposite sides of the planet to a strange and foreign land. Our lives to that point could not have been more different. And yet we saw the world in the same way, framed by the deep and beautiful connections between all things. A beauty to be found in both the wonder of the natural world and in human nature. Even in the human feats that have created the great global challenges of our time, there is a beauty deepened by the quest to overcome these problems. Though our ideas were still forming, we both sensed the solutions to many planetary dilemmas would lie in understanding the complex symbiotic interconnections between all things—from the level of microscopic microbial ecosystems that reside *within us*, to the myriad macroscale environmental ecosystems that *we reside in* and completely *depend on* for our survival.

And so we spoke about health, we spoke about the future. How both human and planetary health depend on the vitality, diversity, and balance of all ecosystems. And how the same natural laws of interdependence, mutualism, and interconnectivity underpin life in all forms. None are truly separate. Diversity and mutualism buffer and protect us. They stabilise environments and make them more resilient to changes and threats and more robust when facing challenges. We could see the same patterns repeated on every level. Fractals of life. Recurring at progressively larger and smaller scales alike. Governing both biology and behaviour. What we might learn from nature, large and small, we might apply to society. The story of microbes, which are everywhere, is such a good example of how everything is interconnected, in ways that were once beyond our awareness. Our conversations soon drifted to how humans might work together—*with* nature. Since microbes are nature, that would also mean working with microbes to overcome the many modern challenges facing our planet today.

For centuries, humans have seen nature as something we must dominate, conquer, and tame, progressively eroding the natural resilience of ecosystems, with the loss of many species more vulnerable than our own. This is not sustainable. This must change. It is time to restore balance in our human social ecosystems, and in the many other ecological systems that we are interconnected with.

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Our thoughts and feelings began reaching into the future, inspired by possibility and hope. But we knew so much needed to change in the world. We began to imagine what we might do, separately and together, to play our part in this. It would be 12 years before we saw each other again. But we never stopped thinking of each other. And of possibilities. The seeds were sown. In the winter that followed, they remained alive and waiting.

#### When Alan Met Susan

The obvious place to start in describing Susan, especially in a book about the microbiome, could be to underscore her international reputation as an acclaimed pediatrician and immunologist, whose highly cited research shines the spotlight on the importance of microbes in immune development and the detrimental effects of declining microbial biodiversity. Yet, by focusing only on her paradigm-shifting research in *The Lancet* and other journals, I wouldn't fully capture the much wider perspective she brings to the complexities of this story, which reaches far beyond ecology to the broader social and economic issues that drive environmental degradation, and with it, human disease.

In fact, it is her more holistic philosophies that I have always most admired—the way she recognizes that the health of humans, the environment, our social fabric, and our economy are interdependent. It takes guts to stand up in front of audiences in science and medicine and plead for the collective body not to lose sight of the holistic purpose. That there must be a stronger focus on finding common ground with more mutually beneficial cross-sectoral approaches that transcend competing interests. Messages of unity and collaboration must come from science and medicine as strongly as other sectors. Her ideas, her passion, and her optimism all struck a deep and profound chord within me.

Susan has smashed through the male-dominated glass ceiling of science. She has made extraordinary discoveries involving the most minute details of the immune system. However, in her writing and talks she leverages this knowledge, bypassing the often-labyrinthine details of immunology, and instead uses the immune system as metaphor for the way that we might all see life. Susan brings clarity to confusion. She reminds us that the immune system has a critical influence on the development and function of virtually every tissue and organ in the body. And therefore, so do microbes.

Seeing the immune system as an intelligent, mobile mind encourages us to look at everything differently—in a much more integrated way. But this goes far beyond the usual confines of human health, to the health of society and the health of the planet itself. Susan uses her credentials as an immunologist to engage people across many fields and to join almost any conversation, because everything becomes relevant from a holistic perspective. It's all interconnected. That's the theme of her research and her broader philosophy on life. These are among the many things that floored me when I met her almost a decade-and-a-half ago.

True to her philosophy, a large focus of Susan's career has been on disease prevention. In this, she encourages long-range thinking and advocates strategies that might not have immediate impact, with a view to long-term benefits for individuals and communities. She is a passionate advocate for how improving our environment, especially in early life, can benefit all aspects of our long-term physical and mental health—and how this can also mean better health and longevity for our children. Again, emphasizing interconnectedness, she argues that we need to apply the same long-range vision to addressing the adverse impact of rapid industrial growth on human health and the environment. Most of all, I admire how she works to build a collaborative mindset and strives to bring people together around any issue. She empowers and inspires others to act and to find opportunity for common ground. She reminds us what we can do—and that every choice we make can make a difference.

It is thanks to these perspectives that we were able to write this book with a wider vantage, one that frames the microbiome revolution in a much broader context, and delivers a more meaningful message as a result. For me personally, knowing Susan has profoundly changed how I see the world. She changed my life. For all the years that we have been apart, these ideas have been growing in me. And it is now my greatest joy that we are together again.

#### When Susan Met Alan

There is just something about Alan that stopped me dead in my tracks. I liked him immediately. It's hard *not* to like him. And I felt like I knew him, though we had never met before. This only got stronger when we started talking. Not only did this clever man have encyclopedic knowledge of the scientific evidence in his areas of interest, he was incredibly passionate and deeply caring, with a unique knack for applying his exhaustive knowledge in new ways, making connections between various strands of research that might not be apparent at first glance.

I was immediately struck by his many marvelous incredible and original ideas, with perspectives I had never encountered before. He was the first person to propose that altering the gut microbes with probiotics might have a role in improving mood and mental health. That might be commonly accepted now, with clear evidence, but in 2003 it was pretty radical. Few took it seriously. But the group of Japanese scientists from Yakult did, that's why they invited him halfway around the world. After listening to his ideas they went on to prove this connection, funding other Japanese scientists to undertake novel animal studies. Very few know about his catalytic role in spurring on research that would change the world. But I was there, listening to a man ahead of his time in so many ways. Within moments of our meeting I knew he was an orator like no other, with such a rich life history to draw on. A life experience that has crafted his strong sense of community and social justice.

Born in Belfast, his early years spanned the height of the sectarian strife of the Troubles in Northern Ireland. Even as a youth he was a passionate defender of the truth, always ready to stand up for an out-group who might be bullied. He already had a strong desire to help others, and was poised to make a difference in a troubled world in whatever way he could. He lived in New York City from the mid-1980s to the early 1990s during its darkest years of extreme poverty, hardship, and violence. Crime and desperation were the products of a failed system, as were alcohol, drugs, and disease. Despair and mental illness permeated the streets. Homeless communities were retreating underground for shelter and respite. His sympathies were always with the people most injured by the broken system. His work and travel through the streets of disadvantaged neighborhoods is a driving force behind his passion and advocacy for policies to address social injustice, health disparities, and economic inequalities. He is always fierce advocate for truth and justice.

He chose a broad liberal arts undergraduate degree—he loves history and the arts—but also completed his pre-med sciences and graduated *magna cum laude*. He already had ideas that the role of diet and nature were greatly underestimated in a range of medical conditions including depression and pursued the doctoral program in naturopathic medicine. Between pre-med and four years of his doctorate, he spent easily as much time studying to become an ND as I did in obtaining my six-year MD degree.

He understands that naturopathic medicine has many limitations and shuns its pseudoscientific associations. He knows that the experience and practice of MDs is distinct and acknowledges that he was able to side-step the required aspects of MD training that would have been overwhelming to him—emergency room rotations, trauma, delivering news to family members that no doctor ever wants to deliver, surgery rotations involving amputations, to name a few. But unlike my medical training, the naturopathic emphasis on nutrition and a more holistic approach to health plays an important part in serving humanity. I studied the body as a series of separate organs, with little integration or holistic understanding; he studied the connections between them and how they are connected to the external environment and nature as a whole.

I completed my training with virtually no knowledge of important things like nutrition and the effect of the whole environment on the health of the whole person. In a world of lifestyle diseases, the importance of nutritional and environmental health cannot be emphasized enough, yet orthodox medicine still places little emphasis on them. Alan was not only an outstanding student, he was greatly admired by his peers and lecturers for his ethics and his attitudes, and with stellar academic performance in place, he was voted valedictorian by his 130-member graduating class. As mentioned, people like him. Alan has never been a clinician. He decided to focus his efforts on sifting scientific evidence and sharing knowledge and its practical applications with healthcare professionals, industry, and the public at large. He has battled anxiety most of his adult life, and his passage through naturopathic medicine into research and writing is as much for his own healing journey as it is for others. I've never met anyone with more respect for medical doctors and scientists. He thinks of us as rock stars. Always a collaborator, Alan has worked extensively with scientists and medical doctors on a number of projects including several books. For a decade, he was an invited faculty member within the Mind-Body medicine courses in Harvard's School of Continuing Medical Education. In fact, it was there in 2012 that he came across my book. A physician in the front row of one of his lectures had a copy of *The Allergy Epidemic*, and recommended it to him!

Working with Alan, on this project, and in life, has been the most joyous experience imaginable. Living in separate hemispheres, we wrote scientific papers together and shared research notes, but hadn't seen each other since 2003. Neither of us realised the depths of how the other still felt. Our reunion, at yet another microbiome meeting in 2015, was much anticipated on so many levels. When it finally occurred, the experience was nothing less than an atomic reaction, cascading across every aspect of our lives, bringing large-scale transformation across our multiple realities. That is a story for another day. But marrying Alan in 2016 was the happiest day of my life. A shared calling has now become a shared destiny.

Literally within hours of meeting each other again, we drew up the plans for this book—to say things that needed to be said. As we began the journey of this book, and of life, we soon saw that, together, the alchemy of our experiences provided a perfect platform for this work. Susan—schooled in orthodox medicine, but with holistic perspectives still shining through from her upbringing in a spiritually minded family. Alan—schooled in holistic medicine, but with a strong detail-oriented, evidence-based perspective. Like opposite sides of the same coin.

The microbiome is defined as the microbes (and their genetic material) found in various ecological niches, such as the human gut or

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skin. Early on in *The Secret Life of Your Microbiome*, you will see that this isn't another pop microbiome book that either claims some probiotic pills are going to cure all that ails us, or 300 pages of fluff and on page 299 you are told to eat your greens. We are, however, deeply grateful to holistic nutritionist Marlies Venier of British Columbia for her inspiring and elegantly designed recipes. A true artisan, Marlies was incredibly generous to loan her fermentation and microbiomeoriented recipes designs for inclusion in the pages of *The Secret Life*. Greens, yes, plus a whole lot more.

There are news stories galore about the microbiome, and how targeting it will transform medicine. It might. We will discuss some of those possibilities. But when you start turning all the news stories into a collage, pinning them on the wall like it's *CSI Miami*, you see they are parroting the same thing—just rinse, repeat, and add a chronic non-communicable disease (NCD). Microbiome linked to Depression! Microbiome linked to Obesity! Microbiome linked to Parkinson's Disease! Microbiome linked to heart disease, allergies, autism, type 2 diabetes, autoimmune conditions, cancer...

Who is asking *why*? Almost all of these news stories end with "*Researchers hope to be able to develop new treatments for*…" We are excited about that, too. But we need to start swimming upstream toward the wellspring, the origins of why *on Earth*, both literally and figuratively, we are seeing virtually every chronic, non-communicable disease being linked to a disordered microbiome. It would seem that something about the way we are living is disordered.

Secret Life is more about the *why*. It is an odyssey in ecology. Just like vaccination, your personal connection to nature and the steps you take to nourish the diversity of gut microbes is good for the herd. For all of us. Understanding these connections that escape the visual senses is critical to conservation. Secret Life is a book about empowerment, and a new way to see the inequalities that surround us. It's okay to ask what your microbiome can do for you, but much better to ask what you can do for your microbiome. Better yet, ask who is manipulating your health by pushing an unhealthy lifestyle upon you.

Ultimately, a crack in a liquid-filled container presents a problem that will not be solved with more buckets or a better bilge pump. The same lifestyle cracks that are warming our planet, causing environmental degradation, and provoking biodiversity losses are of vital interest to your microbiome. Our microbiome. The planet's microbiome. But what mediates microbes? Lifestyle. But what mediates lifestyle? Not just a healthy diet, but so much more.

One of the wonderful aspects of this evolving microbiome revolution is that it is uniting physicians and scientists from many distinct fields. At this point we don't know what the utopian "ideal" microbiome is, or what it might have looked like once upon a time. Just like Atlantis, this fantastical place may be lost forever! But we have learned plenty about the microbiome of our still-living, but increasingly small communities of brethren who eke out an existence not dissimilar to our Paleolithic ancestors. These are our relatives, too. They may have higher rates of mortality in early-life, but seem particularly resistant to chronic non-communicable diseases. What can we learn? All indications suggest that their lifestyles are crystallizing in the form of essential interactions between the immune system and the microbiome, which, in turn, flow outward toward health. We will expand on this in detail.

As the microbiome gives up details about its once-secretive life, it has become clear that it can never be separated from its environment. In other words, every single aspect of the modern environment can find its way to both the immune system and the microbiome. An app luring you to eat fast food? Yes, it is of relevance to your gut microbes. Your mindfulness in everyday life and total time immersed in nature? Also relevant to skin and gut microbes. Which are relevant to health.

We underscore the desperate need for a science that is in our best interests—what we call *biophilic science*. Science, that is, that concerns itself with the promotion of quality of life and sustainability. We may share our frustrations at some of the gamesmanship that goes on, the manipulation of scientific currency and its use for various agendas or stock options. But ours is a hopeful message of unity. Along the way we will provide quotes from those who were waving warning flags many years ago. Scientific soothsayers who were trying to wake us up. Many of them wrote at a critical turning point in human history, the second wave of the Industrial Revolution. Their writings take on so much more meaning now that brighter light is being shed on the importance of microbes, natural environments, and traditional lifestyle habits in the promotion of human health.

Ours isn't a back to nature call. There is no going back. Plus, we kind of like refrigerators, drains, medical advances, Google Books, and while keeping screen time down, at least one of us loves *Australian Survivor*. Nah, we both do. Rather, we provide a "forward *with* nature" message. The PhD scientist perspective. The MD perspective. The ND perspective. Each line of this book was written and agreed upon by both of us.

A better, more connected world awaits. One where we sustain the planet and the life that sustains us. The secret life of your microbiome has much to teach us...

Yours in Health! — Susan and Alan

# Savoring the Biosphere

It is, I submit, a condition of sanity to know the country and the seasons, the hills and the sunrise, the birds and the flowers; to know—not merely to read about—the sting of the wind-driven snow, and the changeful music of the sea. There would be less psychopathology of everyday life if we kept up our acquaintance with the bonnie briar and the cry of the moorland.

— Sir John Arthur Thomson, British Medical Journal, 1914

#### The Thomson Forewarning: Savor the Bliss-Biosphere

It was a dawn of a new era. The Age of Reason had ushered in a renaissance of knowledge, science, and technology, and a new philosophy. Explosions of thought and discovery manifested as hope and faith in a newly mechanized world. Aurora—the mythical heroine casting dawn light—stretching her arms out to many. Change hung expectantly in the air, ready to crystallize in whatever form we would call forth. But what kind of change? Would we move ever more closer to the gluttonous side of industrialization? Or would we heed the call to move forward, utilizing technology *with* nature to restore balance lost? Would we focus on the inherent natural harmony and interconnections of ecosystems, including our own communities, or would we belittle the importance of these things in favor of a far less balanced kind of progress?

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There were many who hoped we might find a peaceful road to progress through equality and justice—for humanity and our environment. But we chose a much more difficult road. A road very dark at times. Yet it has been a century of great discovery, vastly so, and there has also been much light. We have seen advances in public health, surgery, and life-saving medications. Progress toward equality. Even so, progress towards enlightenment has struggled against a relentless culture of immoderate consumption, intent on holding power by building division, focusing on differences and reinforcing fear. It is from within this culture, with eyes conditioned by it, that we first saw the microscopic landscape of the microbial world as a dangerous frightening world filled with countless hordes of tiny enemies, all bent on human destruction. We began waging war.

Through the polarized lens of black-and-white thinking we saw neither complexity nor beauty. Microbes caused infections, so the simple answer was to disinfect the lot of them. They weren't considered to be a part of nature, or at least not one that we needed. We mistook for sinister foes our ancient friends—friends who had been sustaining us since the very dawn of our time on Earth.

Microbes are at the origins of all life on our planet, silent partners to the evolution of every form of life and long, long before *Homo sapiens* arrived on the scene. We are only now learning of their true nature, and, with that, the depths and complexities of our relationship with nature itself. Microbes are fundamental to the core of all ecosystems, large and small, including those in our own bodies. We are even starting to see that microbes may hold answers to the environmental and health catastrophes we have created, oblivious to the vital balance of all ecosystem. The story of microbes is a story of collaboration, of mutual benefit, of balance, and of the inherent interconnectedness of every single thing on this planet. These are lessons that our global society needs now, more than ever.

As in 1914, we stand on a threshold. At a crossroads. Our getting of wisdom in the last century has been a painful process for so many: think of how the suffering of wars have led to medical breakthroughs or the ways in which drug side effects have been brought to light. But it does not have to continue that way. If history has taught us anything it has shown that we need to temper great discoveries with greater wisdom. History is important because it contains many lessons overlooked in the haste for narrowly focused progress. It shows us how we might choose to do things differently this time. In the pages of this book we will often revisit the thoughts of many who have gone before. Many of them swam upstream towards the origins of humanness. Wisdom is built on knowledge. It is also built on awareness. And the ability to reflect—to see things anew and make different choices in this, our new renaissance.

### Three Days of Peace and Medicine

The second wave of the Industrial Revolution (1870–1914) was an incredible period of human history defined by a galloping pace of urbanization, scientific innovation, and technological expansion. Exciting, certainly. Culturally, the Earth seemed to be spinning faster, just as it is now in our own rapidly changing period of human history. At its height in 1914, a 1,500-strong crowd of influential physicians and scientists gathered in Aberdeen, Scotland. The Annual Meeting of the British Medical Association was the Woodstock of medicine at that time. The who's who attendees included medical giants such as Sir William Osler and Carl Jung. Science reporters described the meeting's atmosphere as charged with electricity.

Mostly, the energy at the gathering was manifest in the form of high-voltage optimism. Based on the massive improvements in public health already realized, it was possible to dream of scientific advances and the application of technology in ways that would continue to transform medicine and conquer disease. Well, at least infectious disease. Much like at contemporary medical conferences, commercial exhibitors were on hand to show off their wares: electrotherapeutic devices, surgical instruments, hygiene appliances and chemicals, medicinal foods, mineral waters, therapeutic beverages and, of course, an expanding display of pharmaceutical preparations. Neuropsychopharmacology was taking its first steps, knocking on the door of chemical Zen. Anti-stress, hypnotic agents such as the drug Aponal were unveiled and positioned for sleep disturbances, tension, and anxiety. On the evening of July 31st, 1914, John Arthur Thomson (1861– 1933) strode toward the central podium of the Aberdeen meeting. Eyes were fixed on this internationally respected biologist, a Scottish native who could easily be described as a celebrity. He was invited to give the highly anticipated keynote address known as the Popular Lecture. The annual Popular Lectures had begun a decade earlier and were tremendously successful. The purpose was to disseminate technical aspects of science and medicine through the prism of practicality.

The lectures were a perfect match for Thomson and his ability to translate theories into practical experiences that could be visualized by wide audiences. He had made a career out of delivering complex matters of evolution, science, and health to fellow scientists, medical professionals, educators, and the lay public. The Popular Lectures were the TED Talks of the day. Something to savor. That is, before the current Epoch of Excess.

Amid the wining and dining, and the drinking from golden chalices of technological utopias, Thomson made his way to center stage with some concerns on his mind. Concerns about the future of humans in a world increasingly disconnected from nature. About urbanization and its contribution to mental ill-health. About viewing the environment through anthropocentric lenses of modernity, goggles that obscure biological truths such as the interconnectedness of all life. Each stride toward the podium brought him one step closer to the delivery of a dire forewarning.

Anyone in the audience that knew even a little about Thomson would have understood that he fully embraced scientific exploration as the path to a better world. He wrote extensively about the historical value of science and its application to human progress and quality of life. He referred to science as the torch to wellbeing and emphasized that further understanding of the environments in which humans reside, work, and play could be leveraged to promote health. And in the process, as we apply science to improve the human condition, we should aim to do so with, in his words, "less wasteful exploitation of the Earth." For Thomson, health of the Earth and living creatures within natural environments couldn't be uncoupled from human health. Months earlier, the scientific and medical community had been alerted through press releases that the title of Thomson's Popular Lecture would be *Vis Medicatrix Naturae*. This expression had long-since been attributed to Hippocrates and translates from Latin as "the healing force of nature." It had become an idiom of sorts; many saw a literal meaning, others a figurative interpretation. With increasing focus on technology, surgery, and pharmaceutical drugs, early 20th century physicians were already distancing themselves from the phrase, leaving it for use by naturopaths, pseudoscientists, and shysters selling useless blood purifiers, colon disinfectants, and the like.

Why would Thomson choose a controversial term as the title of his talk? Only a few years before, one of England's most famous physicians, Philip Henry Pye-Smith, had informed an inaugural class of medical students that *vis medicatrix naturae* was a mere "figment which owes its prevalence to its Latin dress." The idea that nature, however it might be defined, provides some sort of vital healing force to humans was incompatible with the dawning of the new medical era. As such, it should be expunged. From the opening lines of his lecture, it was clear that Thomson was well aware that the title would stir interest, and that he would have to cast *vis medicatrix naturae* in a new light.

About a century before it became trendy to discuss so-called positive psychology, Thomson already had a name for what he hoped would be a burgeoning scientific field—"the psychobiology of joy." He drew attention to fledgling research demonstrating that positive emotions could influence physiology, and, theoretically, risk of disease and discomfort. He focused especially on the ways in which stress vs. joy could hinder or help operations within the digestive tract, which in turn can strongly influence health.

As he said: "It may be well for us, on our own behalf and for our children, to ask whether we are making what we might of the wellsprings of joy in the world; and whether we have begun to know what we ought to know regarding the biology or psychobiology of joy." Thomson wasn't secretive about what he felt was the primary wellspring of joy, a source that was being obscured by brick, mortar, and indoor life within an increasingly urbanized world. It was nature. Contact with nature was the fountainhead of joy. The increasing rates of depression coincident with urbanization, could be a byproduct "of neglect of the well-springs of natural joy—of delight in nature among the foremost."

Thomson took the podium and plunged into the deep end of *Vis Medicatrix Naturae*; at the outset he acknowledged there are many ways to interpret the phrase, and in quick succession he dealt with the most obvious. First, he made reference to its interpretation as the traditional use of medicines derived from natural sources. He rebuked the modern medicine men who "scoff too loudly at the old prescriptions," but he wasn't there to talk about that aspect of the phrase. Then he took another major interpretation off the table, that is, the extraordinary capacity of living creatures to heal their own wounds. He made reference to a giant sequoia that spent over 100 years (of its over 2,000-year lifespan) folding its tissue over a deep wound sustained in a fire.

He highlighted another key way in which *vis medicatrix naturae* was explained: the ability of aspects of nature to create conditions for life (e.g., worms and their ability to enhance soil quality). This will be of particular focus in this book, but it wasn't Thomson's primary interpretation of the Hippocratic phrase on that July night. However, he made special note of the ability of "bacteria and infusorians make a clean thing out of an unclean…over the world—on land and sea—a body of scavengers of all sorts and sizes who clean up while we sleep." Throughout his career Thomson was quick to point out that much of nature's beauty, let alone ability to promote life, is a product of unseen, microscopic creatures.

Finally, he removed one more interpretation of *vis medicatrix naturae*, the view that it means the relative absence of chronic disease within wild nature compared to that encountered by domesticated animals and cultivated plants. Since Thomson had written extensively on that topic, especially from an evolutionary standpoint, the crowd may have been anticipating a lecture on the fundamental healthfulness of wild nature. Then, his more pressing concerns and his interpretation was wholly revealed: What, then, do I mean tonight by the healing power of nature? I mean to refer to the way in which Nature ministers to our minds, all more or less diseased by the rush and racket of civilization, and helps to steady and enrich our lives.... There are deeply-rooted, old-established, far-reaching relations between man and Nature that we cannot ignore without loss.... In a period of evolution that has been mostly urban we miss our contact with Nature; most of all, perhaps, in youth, for it remains true of the child who goes forth every day, that what he sees becomes part of him for a day or for a year, or for stretching cycles of years...

With surgeon-like precision, Thomson spent the remainder of his time at the podium making his argument for the medical importance of contact with nature in an urbanizing world. He made the claim that awareness of nature promotes attention, creativity, and awe. Observation of nature facilitates rational progress; nature heals because it speaks to both our moral and intellectual ear, illuminating the importance of concern for others above the self. Ultimately, his message was that contact with nature—soaking it up in a mindful way through all senses, not only the visual—was an essential means to quality of life and a vaccine against psychological problems. It was a serum that was being overlooked.

Thomson foretold the world in which we are now deeply entrenched. His focus on the perils of a childhood disconnected from nature was an effort to have leaders in medicine understand that it would have multigenerational effects. Contact with nature in childhood fosters a realization of the importance of nature, in his words, for stretching cycles of years. Thus, lack of contact with nature in early life begets lack of contact with nature in the early life of the next generation. He emphasized the word *loss*. The diminishing relationship between humans and nature, as he said, cannot be ignored without loss.

Since his task was to deliver the Popular Lecture, Thomson didn't encrypt his words with technical talk and scientific jargon. He was firm in his conviction that a prerequisite of true mental health was a knowing of nature. Long before the World Health Organization formally stated in 1948 that health is not merely the absence of disease, Thomson said this: "Just as peace is more than the absence of war, so positive health is more than the absence of disease."

Thus, he was speaking to the Aberdeen audience from the point of view that mental health, or sanity, meant flourishing. Less psychopathology of everyday life really meant quality of life and the ability to learn, grow, and thrive. It was clear that one of the impending societal consequences of a disconnect from nature would be the erosion of positive health. But who was tallying the losses? Was anybody? He hoped the physicians in the audience would be moved by his plea.

Following his verbal argument for spending time in mindful contact with nature as a medicinal agent, he concluded the session with some visuals. Even without a black turtleneck or having read "The Presentation Secrets of Steve Jobs"—which wouldn't be published for another 95 years—Thomson wowed the crowd with nature images from his personal collection. They were projected on lantern slides while the auditorium was placed under dim light.

Soon after, the crowd dispersed and the hall was in darkness. And so was Europe.

About 72 hours after Thomson wrapped up, Britain declared war on Germany and the British Medical Association wouldn't have a grand meeting for another six years. The war machine transformed medical priorities and undoubtedly advanced medicine in ways that help all of us today. But save for some who applied its principles to heal returning veterans suffering from shell shock, *vis medicatrix naturae* wasn't exactly rolling off the tongues of physicians. Despite the elegant articulation, Thomson's premonitions went largely unnoticed. Only in the first decade of the 21st century, and especially the last few years, have scientists assessed more precisely the toll modern societies pay for living with a relative deprivation of nature.

### Additional Points of Reflection

In our own journey here in *Secret Life* we will reflect upon the many ways in which ignoring *vis medicatrix naturae* manifests itself in modern society. Unlike Thomson, we have the advantage of accumulating

research to draw from. Lots of it. We will make our own efforts to illustrate the abundant research and bring it to life. However, before we follow those scientific tributaries toward their ultimate destination—the argument that all our connections to swaths of visible and unseen forms of life influence us in ways largely unrecognized—some additional nuggets from Thomson can provide a modern point of reflection. Especially important was his introduction of the word *biosphere* into modern language.

Throughout the war that was supposed to end all wars, and right up to the end of his life in 1933, Thomson continued to write extensively on health, nature, and the interconnectivity of life. In a 1902 lecture at the Royal Botanic Gardens Nature Study Conference, Thomson was the first scientist to use the term biosphere in the English language. He was referring to the way life (Greek: *bios*) surrounds us like a living globe (Latin: *sphaera*). To the audience he underscored the ability of this living, seasonally rhythmic sphere to influence our own daily life. The biosphere, according to Thomson, had a grip on our physiology and psychology—our cognition, perceptions, and mood. In his famous Gifford Lectures (1915–16), he expanded his thoughts, stating the following:

There are in our world three spheres which overlap one another. There is the cosmosphere—from the solar system to the dew drop, from the moon to the moonstone, from the sea to the snow-crystal—the Domain of the Inorganic.... Secondly, there is the biosphere, the Realm of Organisms, where the laws of matter and motion still hold, but are no longer exhaustive, since another aspect of reality has sprung up, which we call life.... Thirdly, there is the sociosphere, the Kingdom of Man.

We cannot overestimate the importance of these spheres and the key word *overlap*. For the sociosphere—our cultures and the collective actions we take at given points in history—determines the extent to which we humans appreciate the importance of the biosphere. Not just the importance of the biosphere in sustaining life in obvious ways, such as the ability of green plants to help provide the air we breathe, the water we drink, and the food we eat. The societal recognition, or lack thereof, that this enveloping realm of all living organisms is actually a contributor to our own vitality and wellbeing in less obvious ways as well—that was the bit that Thomson was concerned about. There was a bliss to be found in the biosphere, and he feared we were running away from it, hurtling toward an abyss.

Even though it was inanimate, Thomson viewed the cosmosphere as full of life. Its matter and energy made their contributions to the theater of life. The moon, moonstones, snowflakes, ice, flowing water and all other "structural" aspects of nature's built environment can influence the vibrancy of the biosphere in various ways including climate, weather, air, and water quality, to name but a few. We, of course, contribute to these aspects of the cosmosphere because of the way in which we live our lives in the sociosphere. Thus, the depth of appreciation for the biosphere from a cultural perspective also dictates the extent to which we will pillage or, conversely, protect the biosphere that feeds us both literally and emotionally. Culture and modernity are shaping us toward diminished societal connectivity with natural environments. By extension, what if cultural shifts lean us toward more narcissistic tendencies? This is where we, as stewards of the biosphere, could get ourselves into a place of more pillage and plunder, less protection and preservation.

Maybe Thomson couldn't have imagined huge mechanical arthropods in the form of American cars traversing the Earth by the millions while averaging ten miles per gallon of fuel. He didn't use the term "greenhouse gases" but he surely knew by witnessing the Industrial Revolution first hand that humans could impact air and water quality within the cosmosphere. Stunningly, in his final writings he had this to say: "Many other examples might be given of man's direct influence on the cosmosphere. Let us take one more. Man's production of carbon dioxide by burning fuel has been increasing at a prodigious rate. What if its continued increase leads to an overloading of the atmosphere with this poisonous gas—an overloading which the vegetation, hungry as it is for carbon dioxide, will be unable to lighten! What a hurry there would then be to plant trees!"

In his writings he explained that when humans conquer part of the cosmosphere by building dams and altering the course of rivers this, of course, can alter the biosphere. He knew full well that humans could also directly compromise the biosphere, tearing down trees and contributing to animal extinction: "A minus intersection is illustrated when man stupefies an animal or impoverishes the biosphere by his ruthless exterminations." He claimed that each sphere—cosmosphere, biosphere, and sociosphere—was "enveloping and interpenetrating" each other. It was all connected.

# Time Sink

In making his treatise, Thomson underscored another critical point concerning health in an urbanizing world and our diminishing contact with and knowledge of nature. Since there are only 24 hours in a given day, he was concerned about time use. In the technological world we are a product of what we do, but also what we are not doing. In his words, "Mechanization of man leads to depression and fatigue, and consequent artificial short-cuts out of both." Think energy drinks, stimulants, and caffeine. He stated further: "Along with improved functioning must be included improved use of leisure time—more play and less mere looking at it…we are molded not only by what we do, but also by what we do not do." One of things we were increasingly not doing when he wrote, and are currently not doing as if on steroids, is making contact with nature.

Again, Thomson didn't live in the world in which we do now, where viewing a screen is the dominant use of our leisure time, but he certainly had concerns about the creep of perpetual spectatorship in modernity, an encroachment of non-play into a formerly active life. On the other side of the activity coin, there was often not enough time for mindful reflection. Said Thomson: "Sometimes also there should be mental fasting, there is so little time for reflection between our intellectual meals and almost pathological devotion to print." Both of these devotions—to spectatorship vs. play and salivation to the Pavlovian media bell—could compromise mental health. But they could also minimize an understanding of the web of life. In a nonactive relationship with nature, even assuming any relationship at all, the senses are not fully engaged in the realization that the biosphere needs to be protected. Later we will discuss global inequity and matters of social and environmental injustice. We will focus especially on how these factors impact equitable access to natural environments and equitable ability to reach individual human potential. For now, we will point out that Thomson viewed access to open air, gardens, and sunlight—nature as a matter of equity. When it came to inequality, urbanization, and health, he recognized the advantage held by the elite, stating: "In urban conditions especially, all but a few men and women—the elect or elite—are apt to acquiesce in a mediocre standard of health." He explained that "pathologically [money] means power over the bodies and souls of other people; normally it means securing increased wellbeing." He wanted greater numbers of people to attain greater equality of wealth for its non-pathological purpose—wellbeing.

But money wasn't everything. He turned out to be correct in his assertion that beyond a certain level of decent income—that which supports quality of "food, space, fresh air, sunlight and rest" or what we might now call a "living wage"—wealth does not produce happiness. He referred to United Kingdom mortality statistics showing that although certain factory workers were making higher wages, they had a shorter lifespan compared to those working in natural environments.

On the other hand, as we will discuss later, it would be difficult to obtain time for contact with nature *and* rest while feeling obligated to pull two full-time, minimum-wage jobs at the likes of big-box stores and coffee chains. A living wage at least allows the recipient a *choice* to participate in bliss, or *biosis*, a joyful mode of living. How can we have conversations about *vis medicatrix naturae*, or discuss the importance of active engagement with nature or allowing microbes to work toward our health, while pretending that these broader issues are unrelated?

When speaking of mental health, Thomson recognized that it was not defined by the absence of some sort of clear disease-oriented criteria. There was no distinction between health and mental health. Health was defined as the realization of a life of fullness and freedom. In his words:

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It is impossible to look round today without being impressed sometimes dismayed—by the frequency of mental and nervous disorders.... It must never be supposed that normal and abnormal [speaking of mental disorder] can be distinguished like sheep from goats...health means a harmonious correlation of the parts of the body and of the inner life with the outer; a quality of vigor, difficult to define, which implies reserves of energy and a power of initiative; a fitness of adjustment to the conditions of life in so far as these make for conservation and enrichment; and a certain joyousness which acts as a tonic.

We will frame our unfolding discussions on the interconnectedness of life in relation to human health in the light of an absolute truth: there is no health without mental health. By extension, as we travel through the research surrounding natural environments and personal health, we will do so from the perspective that mental health is not the absence of some coding criteria in a four-inch thick diagnostic manual of mental disorders.

Defined mental disorders such as major depressive disorder are serious, indeed even life-threatening illnesses. However, our discussions within *Secret Life* will span the bridge of relevancy from the "walking wounded" (functioning, but not thriving) to those with bona fide disorders. In other words, the research-proven perspective is that someone with low-grade anxiety and depressive symptoms, feeling chronically tired and perceiving themselves to be in less than optimal health, is suffering, and they are on a trajectory toward diagnoses of many overlapping conditions. Major depression. Cardiovascular disease. Diabetes. Obesity and many others. We will make every effort to speak toward prevention as well as exploring the role of nature-based therapy as an adjunctive treatment in specific mental disorders.

# Nature Play

Thomson wrote extensively on the importance to children of studying, learning, and growing within natural environments, especially in early life. But also of play. He maintained that the play-instinct in mammals had been developed over the ages because it worked toward a health advantage. Playfully, in his own words, he suggested that animals do not play simply because they are young, but rather they keep themselves young so that they may play. With a more serious tone he emphasized free play and games for children. He stated that allowing children to play at their own games was a natural safety valve, the closing of which would be a disaster: "They are opportunities for the free play of individuality, originality, idiosyncrasy—variations, in short, more or less sheltered from selection; they are necessary to the perfecting of powers—physical, emotional, intellectual—which are afterward of critical moment. Play is thus a rehearsal without responsibilities, a preliminary canter before the real race, a sham fight before the real battle, a joyous apprenticeship to the business of life."

In the early part of the 20th century there was an increasing uneasiness concerning the lack of opportunity for fulfilling what appeared to be innate needs for nature play within rapidly growing cities. It is interesting, given the current crisis of indoor life among our screenfixated youth, and the continuing inequity of opportunity for play in green and safe, clean, nature-rich environments, to look back and read concerns that could easily apply today. For many in our "developed" societies, the same lack of opportunity has remained, unchanged. However, even when opportunity exists, the normal drive for nature play may now only smolder, smothered by highly structured activities set up for our children, and the omnipresent screen media that has changed the game.

Oh! The pathos of the efforts of little children in some of the narrow, crowded alleys of our city, vainly trying to achieve this self-realization! There is no sufficient opportunity—the material that formed the opportunity and the need for the nervous reaction of the human race through thousands of generations of upward progress is wanting; no earth to dig in, no trees to climb, no animals to tame, no fruit to gather, no seeds to plant, no banks to jump from, no natural dangers to flee from, no pursuers to dodge. Like drowning men in a great sea

of need, they catch at the miserable straws of opportunity, and sink—many of them never to rise.

- George E. Johnson, Why Teach a Child to Play? 1909.

There are so many layers to the elegant plea made by Harvard's G. E. Johnson. He was pleading on behalf of all children and, more broadly, for generations to follow. Nature play provides opportunity to learn where food comes from, to understand animal behaviors, to witness growth and resilience of other forms of life. It is also an essential course in risk assessment. Within reason (obviously, he wasn't talking base jumping for kids!), Johnson was making the argument that children should be allowed to make their own inquiries and experience the pleasure and possible perils of contact with biodiversity. As we will discuss later, research is now backing up his century-old claims. Nature play not only facilitates joy and positive emotion. It does more. In the course of human history it has been an ideal path to the development of a healthy nervous system.

#### **Three Billion Years and Five Miles**

Life on Earth—green life—has existed for over three billion years. Our own genus, *Homo* is close to three million years old. Really, though, how can we even have a rational perspective on that kind of time? Think about what it's like when your flight is delayed and you have to hang out at the gate for three hours, or when you are in your third consecutive hour-long meeting of the day and you start to realize it's just a meeting to discuss having a meeting about other meetings. Three hours feel like forever.

The point is that it has literally taken ages to shape the Earth and us. For almost all of three million years our human experiences—the traumatic and triumphant, the painful and pleasurable—along with those of our *Homo* genus ancestors, have been within natural environments. Until we started propelling our fellow humans into space and down into the depths of oceans, all of our experiences occurred within a very thin terrestrial portion of the biosphere. Thomson was right in describing the biosphere as an envelope. It is technically the five-mile band from ocean floor to atmosphere where life (microbial at the extreme ends of the envelope) has been found to exist. It would be unrealistic to think that our ancestral time within the biosphere *isn't* presenting itself squarely and resonating deeply in the mind-body interface of the modern, iPhone-clasping man and woman.

Imagine trying to break those three million years into hours. Think of all of those hours our ancestors "waited at the gate," watching carefully for animals to eat and observing the patterns of those that could lead them to fresh water and edible plants. Learning through tragedy the difference between edible and inedible plants, and which animals can bite hard and strike back. All those hours our ancestors spent studying the natural environment—associating the animate and inanimate aspects of nature with sustenance, shelter, and danger—remain within us. Like a tuning fork that seems still, but upon closer inspection is vibrating elegantly, those hours resonate in you right now.

# The Vibration of Vigilance: Biophobia

Psychologists have started to pull the onion layers back on the extent to which our ancestral experiences currently manifest themselves in daily life. Some of the ways our Stone Age experiences dictate modern cognition and behavior are not so subtle, while others appear quite stealthy and seem to show that we are marionettes pulled by the strings of our ancient, nature-based past. The resonance of the past influences the way we absorb the environment, that is, the way we scan sights and sounds that were highly relevant to us many millennia ago.

For example, when we are presented with photos that contain a number of different animate and inanimate objects, we are drawn immediately to any animals in the scene. This is what psychologists call attentional privilege. Rapid attention toward ancient threats from the animal kingdom—the sights and sounds of a slithery reptile for example—can be observed in infants long before they are influenced culturally by scary story books and other conditioning. When psychologists monitor the infant physiological responses to such creatures, they find a very rapid startle response. Not only that, the acquisition of a fear associated with reptiles and spiders is much easier to achieve, and much harder to extinguish, than other more contemporary threats.

Other examples of this resonance are found in the growing field of research called evolutionary consumption. Put simply, this area of research demonstrates that modern consumer behaviors are often a product of the same evolutionary forces that have made us who we are biologically and physically. For example, researchers have found that after we've taken a stroll through a crowded marketplace with lots of commercial offerings, we are more likely to have distinct memories of the locations hawking calorie-dense foods. This enhanced recall had nothing to do with personal taste and food choice preferences; researchers controlled for that. It is more likely a reflection of all those hours spent in the Stone Age foraging for the denser calories required to sustain life.

There are other examples, too. For instance, researchers have linked our ancient need for fresh, preferably flowing, water to some very modern preferences like our penchant for shiny, glossy things. It seems to be why we have a distinctive, generalized preference for the shininess of glossy objects over matte. Think sun reflecting off ripples of water. Sure, there are a few who buck the trend and matte down their high-end European cars, but the dealerships are hardly full of matte-painted vehicles.

The idea of resonance is important because if we can scan scenes and selectively prioritize the living from the nonliving, if we can develop biophobias (innate and immediate fearful reactions to ancestral dangers), and be led to high-calorie and high-gloss consumer products by way of our ancestral past, then it allows us to make the argument that we may also have built-in, or innate, biophilia. That is, at birth we may very well have an attraction to all living things. Although difficult to prove, is it really that far-fetched? Why wouldn't we have an extreme interest in the life that has sustained us? If we can have startle responses and rapid development of phobias toward coiled reptiles that caused many a death to us and our ancestors over our three-million-year *Homo*-genus history, then why wouldn't we have a philia toward other forms of life? The living beings that gave us life. Scientists have shown that we seem to universally prefer images of nature scenes compared to photos of an urban built environment. And it's not like the researchers are stacking the deck by making sure there is garbage and graffiti in the pictures of the human-built environment. Typically, these studies use clean city streets without people or animals. The images of nature usually have lots of green vegetation and sometimes bodies of water, but mostly researchers avoid using extraordinary nature scenes like the Grand Canyon or Himalayan peaks because such scenes are known to provoke very high levels of awe. That would be stacking the deck.

But it's not just that we prefer nature scenes after we contemplate them as if at some wine and cheese-filled art exhibit. Rather, scientists can detect the preference for nature scenes even when they are presented to research subjects at an incredibly rapid rate—for a mere one-hundredth of a second, or what is known by stopwatch aficionados as a "jiffy." We also seem to like more realistic nature images. For example, when researchers display nature images in three- versus two-dimensional form, there are changes to brain oxygen use in ways that would typically reflect improved mental functioning.

In a series of recent brain imaging studies, Korean researchers have compared brain responses to urban built environments and rural nature scenes, using functional magnetic resonance imaging (fMRI). The results of their studies have been remarkably consistent—scenes of natural environments increase activity in brain regions associated with positive mood, emotional stability, sharing resources, empathy, and love. Again, this study was not set up as an act of contemplation; images of nature were presented in a two-minute block, but the researchers showed a new image every couple of seconds. By comparison, city scenes reliably increased activity in the amygdalae. These almond-shaped structures are known as the fear centers because they process threat, arousal, and risk assessment.

#### **Obscuring the Roots**

These types of studies lend support to Thomson's claim that "there are deeply-rooted, old-established, far-reaching relations between man and Nature," relations that might be pathologically suppressed by ways of life and cultural changes that have been shockingly rapid in the span of evolutionary change. These studies, and many others we will refer to in the following chapters, indicate that biodiversity matters to positive emotional health. We aren't just looking at "green space" or "the countryside" while in an MRI scanner or engaged in similar psychological studies. When we look at nature images we are typically seeing much more of the biosphere, Thomson's "Realm of Organisms," or a surrogate of their representation as opposed to what we find while viewing scenes of urban brick, steel, and glass.

Thomson focused on the psychopathology of everyday life because he knew that being in a place of positive emotion, or, put simply, a good mood, was an asset to our ancestors. *Joie de vivre* has helped us survive and thrive. Modern science backs up that assertion. In the harsh world of our ancestors, can you imagine how refreshing it would have been to taste fresh water? Can you imagine after a long hunt or forage how delicious food must have tasted, even though it wasn't laden with highly-processed sugars, fats, and sodium? Even though it wasn't wrapped up by the delicate hands of a sophisticated marketing machine that includes a character in a clown suit cajoling us and our children to eat fast food, it seems safe to assume they were still lovin' it.

The point is that even while sidestepping predators, our ancestors must surely have looked around themselves with fascination, amusement, and awe—cognitions and emotions that were all experienced in natural environments. By extension, the environment in which those experiences took place is an essential part of who we became as humans. The theater. Here, one of our prevailing arguments is that contemporary science often looks at human existence outside of its larger theater—outside of its functional connectivity to the past, and away from the unseen and seemingly unrelated forms of life that surround us.

But cultural forces are strong, and no matter what our brain responses may be in an MRI machine, we can easily overlook what might be good for us. The progressive loss of human interaction with biodiversity is something contemporary researchers refer to as "extinction of experience." As we will discuss, the extinction of our experience with biodiversity cannot be separated from our role in the ongoing extinction of biodiversity itself. Perhaps if we were more fully aware of Thomson's *vis medicatrix naturae*, we would be less likely to stand by idly and remain spectators to global biodiversity losses, climate change, environmental degradation, and dramatic increases in chronic, non-communicable diseases.

# The Dysbiosphere

Our existence, and that of our ancestors, was without massive environmental consequence until we started to cultivate crops and domesticate animals some 12,000 years ago. But even in that time span, things changed at a snail's pace until the primary Industrial Revolution. Today, it isn't difficult to make the argument that the biosphere first described by Thomson is now a *dys*biosphere. Life in our sphere is in distress. We are in the midst of massive biodiversity losses, global environmental degradation, rapid urbanization, and, of course, the reality of climate change.

So, what is dysbiosis? This Greek-rooted term translates as "difficult living," or "life in distress." Often it is used in the context of disturbances in the life of microbes that inhabit our skin and gastrointestinal tract. In the microbiological sense it is more narrowly defined as marked changes to the structure of complex microbial communities that would otherwise be living in a peaceful manner with us. In other words, it is a disturbance in the world of our microbial friends, and since their world is our world, it really means there is a disturbance on us (skin) or within us (gut). Technically, it is a state of change that involves the loss of beneficial microorganisms, and/or the expansion of potentially harmful microbes, and/or the loss of overall microbial diversity and we will have much to say about that topic later.

Within *Secret Life*, we will use the term dysbiosis (or dysbiotic) in both its global meaning—life in distress—and its more narrow microbial meaning. Most often the distinction in use will be obvious and we have made efforts to specify microbial dysbiosis where appropriate. We will also use the term probiotic (which translates as "promotion of life") with a broad interpretation, and not always simply as a commercially available product sitting on a shelf. Although we will discuss them, *Secret Life* isn't a book about probiotic supplements; it is a far larger discussion of the ways in which lifestyle—and the forces that drive lifestyle—interact with unseen life, and, ultimately, the quality of all life on Earth.

Looking around at the state of affairs in global health, divisiveness in politics, and socioeconomic inequalities, it is easy to see that life is in distress. The rates of non-communicable diseases—type 2 diabetes, cardiovascular disease, asthma, allergies, autism, depression and other mental disorders, autoimmune conditions (e.g., Crohn's disease, ulcerative colitis, celiac disease), neurodegenerative diseases, and others—are now described as a global epidemic. Tellingly, many of these conditions are increasing in tandem with urbanization, westernization, and the lifestyle of modernity, including a drift from traditional diets and contact with nature. This is dysbiotic drift.

### **Climate Change and Dysbiosis**

No, climate change isn't a hoax. The undeniable scientific facts aren't a product of some foreign regime in cahoots with 97 percent of the international scientific community. We can see the evidence in the air bubbles deep in the ice core throughout Antarctica. This long-trapped Pleistocene air provides a clear The concept of global warming was created by and for the Chinese in order to make US manufacturing non-competitive.

— Donald J. Trump, 2012

way to demonstrate that carbon dioxide and other greenhouse gases in the current atmosphere are the highest they have been in 650,000 years. The colossal increases in carbon dioxide in the atmosphere since the Industrial Revolution, and especially over the last halfcentury, are in line with separate research that has been tracking human-generated sources. This is real. Not a conspiracy against manufacturing and commerce. Quite the opposite. Lifestyle is influencing the cosmosphere. And the biosphere.

In 1933, Thomson visualized a day when there would be a rush to plant trees to offset atmospheric carbon dioxide. However, he was comforted in reminding readers, correctly, that "since carbon dioxide

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is soluble in water, the sea acts as a regulator of the proportion of this gas in the air." Remarkably, data published in 2014 by the World Meteorological Organization indicates that we are now past a point where human-manufactured carbon dioxide can be handled by the absorbency powers of oceans and plants. Even the best brands of paper towel have a limited capacity to clean up if the tap is left running.

It may seem silly to even discuss these realities and make the point that a collective of the foremost international scientists do not waver from their consensus statement: "Human influence has been the dominant cause of the observed warming since the mid-twentieth century." It would be tempting to just have a giggle about a tiny minority of misinformed (or worse, cleverly slick with a self-interested agenda) climate deniers that have a bit of a platform on the contemporary soapbox known as social media. But we can't laugh it off. Their ignorance spreads like the invisible greenhouse gases, and, sadly, these merchants of doubt have actually penetrated the minds of those who should know better.

# **Trust in Societal Teachers**

Some of those who should know better are medical doctors, often held out to be the leading experts on lifestyle and the environment. The public generally sits up straight when a doctor speaks. Medical organizations cherish and encourage this sovereignty, rushing to the scene lest any intruders suggest that the Emperor might need a new Armani suit. The basis of this privileged position regarding knowledge of the environment—in all aspects of the term—and the way it presses upon the health of the person showing up in a clinic, is transparently, tissue-paper thin.

Numerous studies show that medical school education related to diet, exercise, and other specific lifestyle factors is paltry at best. Moreover, graduating medical students report lack of clinical preparedness to handle specific diet and exercise advice. Test scores on nutrition knowledge average about 50 percent—no different than they were in the 1970s and 1980s. Ecological medicine—teaching as if the environment matters—is essentially nonexistent. Which brings us back to climate change. Shockingly, in a pair of 2016 studies that polled the members of the American Thoracic Society and the American Academy of Allergy, Asthma & Immunology (AAAAI), only seven to ten percent reported being very knowledgeable about the association between climate change and health, with as many as 47 percent indicating that climate change is either not happening, or is mostly a natural phenomenon, or that human activity is no more a factor than natural processes. Which means that 47 percent of physicians in specialties that deal with where the environment meets health—allergy, asthma, lung conditions—are completely at odds with science. These disheartening statistics aren't advertised in the abstract of the AAAAI study, which paints a rosy picture of physician awareness, but are readily available in the tables within the report itself.

Doctor means "one who teaches" (Latin: *docēre*). Yet it seems obvious that fitness for teaching matters of lifestyle, individual vs. social responsibilities, ecological influences on health, and how these variables intersect in the doctor's office is based on *docēre* self-teaching and political views. Research involving US middle- and high-school teachers also shows that personal political ideology predicts their classroom approach to the topic of climate change. We have a ways to go in educating our educators, and undoing the damage of the merchants of doubt.

Biodiversity losses aren't a hoax either. Scientists, if anything, have been ultra-conservative about their estimates of historical species losses over the millennia. Just like normal oscillations in global climate over tens of thousands of years, so too have there been lots of species that have had their day in the sun and are long gone. Extinction of animal and plant life has been part of the Earth's history for as long as there has been life upon it. However, just like ongoing climate change and  $CO_2$  in the atmosphere, what we are now witnessing in terms of species loss is not a normal oscillation. Current species loss, by some estimates, is one thousand times higher than the normal oscillations.

Of course, there have been times in the Earth's history when massive extinctions have occurred—at least five big ones that we know of, including the one that ended the reign of kids' beloved dinosaurs. We are now in the midst of a sixth Big One. In fact, scientists are warning that what we are witnessing before our very eyes is the largest loss of species since the loss of dinosaurs 65 million years ago. In 2015, after careful analysis of the existing data on biodiversity loss, an international team of expert scientists led by Gerardo Ceballos had this to say in the pages of *Scientific Advances*: "If the currently elevated extinction pace is allowed to continue, humans will soon (in as little as three human lifetimes) be deprived of many biodiversity benefits. On human time scales, this loss would be effectively permanent because in the aftermath of past mass extinctions, the living world took hundreds of thousands to millions of years to re-diversify."

The researchers went on to a call for urgent action: "Avoiding a true sixth mass extinction will require rapid, greatly intensified efforts to conserve already threatened species and to alleviate pressures on their populations—notably habitat loss, overexploitation for economic gain, and climate change. All of these are related to human population size and growth, which increases consumption (especially among the rich), and economic inequity. However, the window of opportunity is rapidly closing."

Truer words were rarely spoken. Especially about the essential need to move quickly on the last embers of opportunity. It's so hard, though, for us humans to take action on things that appear so far removed from the present. Our dominant thoughts are about the here and now. Avoiding pain, and feeling pleasure. Today.

Perhaps if we weren't so disconnected from the natural environment, and a little more tuned in to the way in which *vis medicatrix naturae* can provide immediate benefits, we would protect the source of those benefits. The same way a dog protects the human companion who nourishes it with food and love. Psychologist Elizabeth Nisbet calls this awareness of nature's immediate benefits "the happy path to sustainability." The problem is, our good friend Dr. Nisbet has found that humans consistently undervalue the extent to which experience in natural environments can subsequently promote a healthy mental outlook and make us feel more vital. Changing that underestimation through experience and education—is part of the solution.

#### Cats, Cows, Clover—It's All Connected

In the pages of *Secret Life* we will explore the ways in which life and lifestyle are interrelated—often through our microbes. To set the stage for this, a brief mention of Thomson's illustration of the web of life and lifestyle—a descriptive that combined the writings of Charles Darwin and the famed biologist Thomas H. Huxley—seems worthwhile.

Darwin conducted clever experiments demonstrating the essentiality of insect pollination. When patches of red clover growing in fields were shielded from visits by bees (Darwin covered a clover patch with gauze-like material, allowing plenty of light and water for growth) he found that seed production—providing opportunity for new red clover growth—was minimal. But there was more. The visits by bees were limited by higher numbers of field mice because mice were enemies to early beehive development. However, the number of mice was determined by the quantity of neighborhood cats. More cats meant less mice, more bees, and thus more clover.

This remarkable observation, which is really the heart of ecology, was built upon by Huxley. Although somewhat in jest, he added a social sphere to the clover. In lectures published in 1872, he noted that the quantity of neighborhood cats were a product of the kindly women who cared for them; thus, since the entire British Empire was secured by strong soldiers who fed upon beef, which was from cows that grazed upon clover, it was actually the animal-loving women, crudely referred to as "old maids," that were influencing the status of global affairs. Light-hearted as it may have been, it is a poignant illustration of the beautiful web of life and the many underappreciated threads joining Thomson's cosmosphere, biosphere, and sociosphere.

In this modern era we are searching for something to save us from ourselves. In the last decade, stacks upon stacks of book titles have included climate change in the title. Over 7,000 by our count on Amazon.com. More than 17,000 books include happiness somewhere in the title, more than 7,000 use the term lifestyle, 1,700 include longevity, and 1,600 the word biodiversity. What is missing, in our view, is a detailed description of why these topics—or buzzwords—are often discussions that are one and the same. We will provide our own clover stories as we discuss *vis medicatrix naturae*.

We close out this chapter with the words of another famous Scotsman. Famed naturalist John Muir, known affectionately as the "Father of US National Parks" because of his influence on their late 19th century development, left us with a treasure trove of elegant prose. At the very time Thomson was writing about *vis medicatrix naturae* on the other side of the Atlantic Ocean, Muir was approaching the end of his life. They would have both walked the very same Scottish terrain in their youth. Remarkably, both men were born in East Lothian, an area just east of Edinburgh. As you can see, they had the same Big Picture ideas: "When we try to pick out anything by itself, we find it hitched to everything else in the universe." (John Muir, 1869.)