HARNESSING EVOLUTION'S GIFT OF BORDERLESS WONDER TO OPEN NEW ECONOMIC FRONTIERS FOR GLOBAL SUSTAINABILITY: A VISION, A ROADMAP, AND A PLEDGE INSPIRED BY FRANCISCO J. AYALA'S PASSION FOR SCIENCE AND ART

Aprovechar el don de la evolución de las maravillas transfronterizas para abrir nuevas fronteras económicas a la sostenibilidad mundial: una visión, una hoja de ruta y un compromiso inspirados en la pasión de Francisco J. Ayala por la ciencia y el arte

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ABSTRACT: Evolution transcends the natural world, oblivious to political borders. It is at the transnational scale of Earth's evolutionary heritage where transformative scientific discoveries await. These discoveries' potential to bolster environmental health and resilience by unmasking the most consequential evolutionary trajectories is increasingly coming to light. However, overlooked is a borderless mega-reserve of wonder unearthed along these trajectories and begging to be recognized and harnessed as an unmatched resource for charting a global pathway into a sustainable future. The article backs this assertion with a business model designed to engender a new-generation world travel industry that opens transnational frontiers for the confluence of science-, art-, and faith-based appreciation and guardianship of nature. This model reinforces with economic energy the inspiration it has drawn from Francisco J. Ayala's engagement of art to bridge evolution, creativity, and the future of humanity, and from his treatment of science and religion as complementary windows into human understanding of the world.
KEYWORDS: evolution, wonder, science, art, transnational resort, sustainability, global knowledge economy.

RESUMEN: La evolución trasciende el mundo natural ajena a las fronteras políticas. Y es en la escala transnacional del patrimonio evolutivo de la tierra donde aguardan descubrimientos científicos transformadores. Al descubrir las trayectorias evolutivas más relevantes se hace cada vez más evidente el potencial que estos descubrimientos tienen para reforzar la salud y la resistencia del medio ambiente. Sin embargo, se ha pasado por alto esa megareserva de maravillas sin fronteras que se desvela a lo largo de estas trayectorias y que suplica ser reconocida y aprovechada como fuente inigualable para trazar un camino global hacia un futuro sostenible. El artículo respalda esta afirmación con un modelo de negocio diseñado para generar una industria mundial de turismo de nueva generación que abra fronteras transnacionales a la confluencia de la apreciación y la protección de la naturaleza basadas en la ciencia, el arte y la fe. Este modelo refuerza con un añadido de energía económica la inspiración extraída del compromiso de Francisco J. Ayala con el arte para tender puentes entre la evolución, la creatividad y el futuro de la humanidad, así como de su tratamiento de la ciencia y la religión como ventanas complementarias a la comprensión humana del mundo.
PALABRAS CLAVE: evolución, maravilla, ciencia, arte, modelo turístico transnacional, sostenibilidad, economía global del conocimiento.

1. **PROLOGUE**

In 2006, Francisco Ayala, together with John Avise—one of his distinguished "academic sons"—embarked on organizing a series of state-of-the-art colloquia hosted by the Beckman Center of the U.S. National Academies of Sciences, Engineering, and Medicine. United by the theme *In the Light of Evolution* (*ILE*) and spanning ten years,[1] the *ILE* series sought to foster the

[1] The *In the light of evolution* Arthur M. Sackler colloquia of the U.S. National Academy of Sciences, organized and edited by John C. Avise and Francisco J. Ayala and published in 10 volumes by the National Academies Press and in *PNAS—Proceedings of the National Academy of Sciences of the United States of America*, include: *Volume I: Adaptation and complex design* (https://doi.org/10.17226/23542); *Volume II: Biodiversity and extinction* (https://doi.org/10.17226/12501); *Volume III: Two centuries of Darwin* (https://doi.org/10.17226/12692); *Volume IV: The human condition* (www.pnas.org/cgi/doi/10.1073/pnas.1003214107); *Volume V: Cooperation and conflict* (https://doi.org/10.17226/13223); *Volume VI: Brain and Behavior* (https://doi.org/10.17226/13462); *Volume VII: The human mental machinery* (https://doi.org/10.17226/18573); *Volume VIII: Darwinian thinking in the social sciences* (https://doi.org/10.1073/pnas.1411483111); *Volume IX: Clonal reproduction: Alternatives to sex* (https://doi.org/10.1073/pnas.1508087112); and *Volume X: Comparative phylogeography* (https://doi.org/10.17226/23542).

appreciation of evolutionary biology as a consolidating foundation for the life sciences while addressing some of the most intellectually engaging as well as pragmatically important societal issues of our times (Avise & Ayala, 2007). The *title* of that series was a tribute to Theodosius Dobzhansky—Francisco Ayala's "academic father," considered among the 20th century's most preeminent geneticists and evolutionary biologists—who famously titled one of his influential articles "Nothing in biology makes sense except in the light of evolution" (Dobzhansky, 1973). The *objective* of that series reflected the new dimension through which Francisco Ayala further enriched Dobzhansky's position by asserting that "only under the prism of evolution it is possible to understand what we humans are, from where we came, and the possibilities that the future brings us" (Ayala F. J., 1999, p. 15).

2. THE MASTERY OF ALIGNING EVOLUTION, CREATIVITY, AND THE FUTURE OF HUMANITY

Francisco Ayala's pursuit of insights into evolution as gateways into world-enhancing perspectives was greatly complemented by his exceptional ability to engage art authoritatively in celebrating and "taming" scientific knowledge. As documented by Susana Pinar García (2016), the origin of this skill and mindset can be found in the life-long friendships that Francisco bonded, since his childhood and adolescence in his native Spain, with that country's future great artists of international renown. These transformational bonds—immortalized in the art collection that nurtured Francisco's and my life together and fueled synergies of our respective professional missions—prominently included figurative painter Joaquín Pacheco (La Gran Enciclopedia Vasca, 1976); architect, sculptor, and painter Joaquín Vaquero Turcios (Bousoño, 1999); and Luis de Pablo, composer and one of the major figures of avantgarde music (Instituto Cervantes, 2015).

Evolution also prominently shaped Francisco Ayala's foresight about not just compatibility but mutually beneficial interface of science and religion resulting in a larger benefit to humanity. In his article on "Evolution and religion" published in *Zygon—Journal of Religion and Science* in 1968, Francisco stated:

> To be meaningful to modern man, religion must be formulated in an evolutionary context…If we live in an evolving world, it is possible for

> man to contribute to the betterment of that world and thus to make his life meaningful (Ayala, F. J., 1968, pp. 426-427).

For Francisco Ayala, creativity was the cornerstone of human life's fulfilment. And he viewed artistic creativity that paid tribute to other qualities of human intellect as having an unrivaled role to play in our appreciation of the exhilaration and positive force of human creativity. No doubt, contributing inspiration towards this view were two treasures of our art collection, two large Japanese scrolls whose magnificence and significance as masterful paintings on silk executed in the 19th century is hugely augmented by their portrayal of authors of two immortal legacies that originated during the Heian Period (794-1185) of ancient Japan: Lady Ono no Komachi, a poet of great renown, and Lady Murasaki Shikibu, best known as the author of *The Tale of Genji*—recognized as the greatest masterpiece of Japanese prose and thought by many to be the first novel in the history of world literature.

The novel way in which Francisco Ayala applied his exploration and appreciation of artistic creativity to evolution underscores his talent as "master interpreter" of evolution. Quoting from his book titled *Evolution, Explanation, Ethics, and Aesthetics*:

> Natural selection is…a creative process. It does not create the entities upon which it operates, but it produces adaptive (functional) genetic combinations that could not have existed otherwise… Natural selection may rather be compared to a painter who creates a picture by mixing and distributing pigments in various ways over the canvas… It is inconceivable that a random combination of the pigments might result in the orderly whole that is the final work of art, say, Leonardo's *Mona Lisa* [or, I will add, the portraits of Lady Ono no Komachi and Lady Murasaki]. In the same way, the combination of genetic units which carries the hereditary information responsible for the formation of the *vertebrate eye* could have never been produced by a random process such as *mutation*—not even if we allow for the 3 billion years plus during which life has existed on Earth. The complicated anatomy of the eye, like the exact functioning of the kidney, is the result of a nonrandom process—natural selection (Ayala, F. J., 2016, p. 105).

This quote is exemplary of Francisco Ayala's unique ability to convey evolution in a most engaging manner to broad public, systematically to integrate art, philosophy, and the emphasis on evolution's harmony with religious beliefs into interpretive journeys of discovery of the ever-evolving world in which

nature and culture are intricately intertwined. This bond is mirrored in the human capacity to appreciate the aesthetic qualities of not just works of art but also of natural objects and sounds—be it a sunset or sunrise or bird songs, as he notes in the chapter he wrote for the book *On Human Nature: Biology, Psychology, Ethics, Politics, and Religion* that he co-edited with Michel Tibayrenc (Ayala, F. J., 2017). Hence, my revelation that our art collection extends from indoor spaces into our garden's design, marrying paintings and sculptures with natural elements and vistas, should come as no surprise.

I inject this personal angle to further underscore the nurturing role that art played in bolstering the depth and reach of Francisco Ayala's appreciation and interpretation of evolution as a symphonic masterpiece that reveals the natural world in its fluidity in time and space, that enriches and allies science, art, and religion, and that heralds planetary unity while sensitizing us to life-changing experiences of this life-affirming unity. This largely overlooked dimension of Francisco's comprehensive legacy has had a major influence on my conceptualization and vetting of a sustainable development paradigm that engages science and art to awaken borderless reserves of economic energy engendered by evolution and that could profoundly and decisively accelerate the world's journey towards a sustainable future.

3. THE PROMISE OF AWAKENING THE ECONOMIC MIGHT OF EVOLUTION

Let's enter the grand evolutionary theater of the natural world and reflect on it with the mindset of the ever-faster transformation of the global economy into a knowledge-based economy. I've perceived this grand theater of natural marvel as an immense repository of potential scientific knowledge —the "mineral," the "raw material" for the knowledge economy (Ayala, H., 2017). Unlike oil that has shaped the industrial economy and whose overall global amount is just the sum of oil reserves found across the world, the knowledge mineral resource is greatly augmented in volume and value by the knowledge-packed evolutionary, ecological, and other relationships that pervade our planet's natural heritage on infinite scales, blind to political borders. Consequently, a transnational—ultimately, global—perspective ought to be the point of departure towards mobilizing nature's knowledge capital (Ayala, H., 2021); capital that grows in volume and value the more it is explored, extracted, and used.

The inestimable wealth of knowledge embedded in the threads of the earth's evolutionary fabric holds enormous promise to revolutionize the existing approaches to conservation and sustainable development across the world. As increasingly revealed by an emerging field of research that uses genetic data to identify unique evolutionary lineages of species, the existing networks of protected areas across both the marine and terrestrial realms of planet Earth largely fail to overlap with areas of high evolutionary diversity and evolutionary potential for species to evolve and adapt (see, for example, Huang & Roy, 2015; Daru et al., 2019). The magnitude and significance of this failure call for the recalibration of global conservation strategies.

The *Tara* Pacific Expedition, which involved an international team of researchers and ran continuously from 2016 to 2018, applied a pan-ecosystemic approach on coral reefs throughout the Pacific Ocean, drawing an east–west transect from Panama to Papua New Guinea and a south–north transect from Australia to Japan, sampling corals throughout 32 archipelagoes (Planes et al., 2019). It has offered unprecedented insights into biological complexity and evolutionary trajectories of coral reef ecosystems, including a milestone disclosure that coral reefs are home to the greatest microbial diversity on Earth—a diversity of crucial, not yet fully explored importance for coral reef health, resilience, and nutrition (Galand et al., 2023; Planes & Allemand, 2023).

These bounties of new knowledge that are coming to light on unbounded geographical scales are also bounties of wonder, revealed along science-mapped paths that wind across and beyond nations' jurisdictions. I have asserted that this dynamic and unlimited wonder supply represents a mammoth economic asset of unparalleled potential to benefit humanity. And to make this assertion tangible, I have equipped it with a business model I have named *transnational resort* (Ayala, H., 2020) and built on the following rationale: Evolution has provided a nurturing womb for this model; a skillful marriage of science and art will endow this model with the capacity to elevate the wonder of the natural world's connectivity to a centerpiece of both the ideal and the pursuit of global sustainability; and this model's implementation consistently on transnational scales will prime it for stewardship of unmatched legacies in championing science diplomacy, promoting harmony of science and faith, and instigating transnational bridges of peace. It is on this rationale and through its activation that I am harnessing the inspiration I have drawn from Francisco Ayala's mastery of aligning evolution, creativity, and the future of humanity and which I aspire to take to new frontiers.

Allow me to briefly substantiate this aspiration, starting with a diagnosis of a fundamental limitation that pervades planning, design, and development of the pilar of world travel, the international resort-hotel enterprise.

The world over, the locations of existing and planned resort projects, particularly in the luxury segment, exhibit an overwhelming overlap with some of this planet's most biodiverse habitats and prominent crossroads of nature's evolutionary and ecological connectivity. Yet, these exceptional locations are entering the global market as merely premium real estate. Entirely overlooked and wasted are many of these settings' affinities with variously distant ecosystems, geological formations, and other pillars of Earth's architecture. Two factors must come together to mobilize and harness the value of these affinities. One is an alliance with science since scientific research holds the key to revealing the relationships and correlations within and among global ecosystem networks and evolutionary pathways. The other is a skillful interpretation that will engage and extol these science-mapped webs of relationships as far-reaching labyrinths of wonder that will not only grant the resort product major added value and immunity to imitation but will also serve as channels of environmental pledges of boundless trajectories. It is in this context that—in parallel with Francisco's passion about Japanese art—I have drawn profound inspiration from the Japanese landscape art of *shakkei*.

The technique of *shakkei* ("borrowed scenery," "landscape captured alive") is boundless in bringing the beauty of variously distant natural environs directly into the layout of the garden, with no physical incursion into these areas (see, for example, Itoh, 1973; Le Toquin & Bosser, 2006). *Shakkei* intertwines the natural features of a specific site with natural sceneries visually accessible from that site into a giant piece of art. What an intriguing resonance with the spirit of Joaquín Pacheco's painting "Baño blanco" (white bath) in which the rock placed on the bath's floor visually transcends the glass wall and becomes one with the rock formations that rise from the sea horizon. No doubt, this painting, as my daily companion, has stimulated my thinking and writings about the potential of using a *shakkei*-inspired approach as a powerful zoning instrument that could grant strict protection to ecologically vulnerable areas while allowing and enhancing the appreciation of their magnificence.

But I have not stopped there. Panoramic views explored as interpretive channels and complemented with ever-changing exhibits would bolster the appreciation of a particular site's anchorage in a natural milieu that is a living part of science-disclosed paths of connectivity among land and ocean ecosystems past and present (Ayala, H., 1995). Applied to a resort master plan, such an

approach would bring "science—and, through science, conservation—to the heart of a business model in which quality, competitiveness, and prestige grow along with the geographical footprint of the underwritten research" (Ayala, H., 2020, p. 1584). It would empower the resort continuously to upgrade the complexity, interest, and educational value of its offer of intellectual treats through a lasting in-flow of wonder generated through ongoing scientific discoveries. It could effectively incorporate the broad perspective offered by satellite images that, as noted in a recent issue of *American Scientist*, permit to observe changes on a global scale and compare ecosystems over time and across space (Madin & Foley, 2021). The experience—*live* and uniquely meaningful by being offered from a vantage point inside a vast labyrinth of wonder—will be profoundly different from experiences gained in a museum, whose exhibits are enveloped by contextually foreign settings. Notwithstanding many museums' embracement of the potential of virtual reality to add new dimensions to their exhibits, no virtual narrative can replace the power and emotion of embarking on a far-reaching experience of evolutionary and ecological connectivity from an authentic steppingstone within that experience, surrounded by indigenous qualities of light, color, and aroma.

By acting as a catalyst of an unbounded interplay of science and wonder, the transnational resort business model also opens new frontiers for the confluence of science-based and faith-based appreciation and guardianship of nature—a cause whose stewardship profoundly defined Francisco Ayala's treatment of science and religion as complementary windows into human understanding of the world. He wrote:

> Science may inspire religious beliefs and religious behavior, as we respond with awe to the immensity of the universe, the glorious diversity and wondrous adaptations of organisms, and the marvels of the human brain and human mind. Religion promotes reverence for the Creation, for humankind as well as for the world of life and the environment. Religion often is, for scientists and others, a motivating force and source of inspiration for investigating the marvelous world and solving the puzzles with which it confronts us (Ayala, F. J., 2016, p. 297).

Likely the most consequential characteristic of the transnational resort model is that it leaves intact the scientific value and intellectual property of basic research findings underwritten by the resort. As demonstrated by this model, it is of zero value to the resort to seek monopoly over the funded basic research as opposed to the utmost value of monopolizing the resort-anchored

interpretive treatment of that research to dazzle and stimulate the mind. This translates into a strong incentive for the resort project to encourage unrestricted use by science of the underwritten research findings as input into new research endeavors and as a foundation for ambitious conservation initiatives on transnational scales, since such a use delivers guarantees of continued appreciation of the investment in terms of both business and legacy rewards. The transnational resort model's ultimate goal is to awaken the self-interest of the international resort industry to align private enterprise system with investments in geographically unrestrained basic research endeavors and to bolster the prestige of these investments by the assurance that scientific knowledge yielded by these endeavors of transnational scales remain permanently accessible and available to all.

4. **EPILOGUE**

Let's re-enter the global evolutionary theatre of the natural world—a giant repository of the raw material of knowledge that could propel the emerging global knowledge economy as profoundly as oil defined the industrial economy while doubling in value as an infinite mesh of wonder that could revolutionize the sophistication, rewards, and purpose of world travel.

The transnational resort model is intended as a catalyst for radical re-thinking—on the premise of hard-nosed economics—of the potential of the existing and future hospitality infrastructures that proliferate in most extraordinary natural settings across the globe. Integral to the accomplishment of this paradigm shift is a proactive design of transnational resort portfolios based on science themes of audacious research ambitions and geographical scopes and acquiring a global transformative capacity for linking science, conservation, and economic development in a manner that has never been attempted before. The collateral benefit of tapping into the growing trend of mega-sized eco-philanthropy and science philanthropy (Verdon et al., 2021; Gruby et al., 2023) via the offer of novel investment opportunities on multi-country scales will be also unprecedented.

As experiential portals into geographically unconstrained paths of scientific breakthroughs, transnational resorts will acquire the capacity to excel as cradles of science diplomacy and gateways into routes of international collaborations. They will be in a singular position to host painters, composers, and other artists, thus serving as nurturing grounds for artistic creativity that

will extol and celebrate the borderless complexities of the earth's life-support systems. What an inspirational resonance with Francisco Ayala's premise that science, art, and creativity are extraordinary dimensions of human life that deserve to be fulfilled in concert and to the fullest.

I view the fast-progressing transformation of the global economy into a knowledge-based economy as a most momentous opportunity for activating the collective potential of the international resort enterprise to become the most powerful force to shape the world's journey towards sustainability. This view frames my mission to chart the implementation path. I embrace the prospect of aligning this path with the Comillas Pontifical University's excellence in capacity building for sustainable development and with the University's commitment to nurturing science and to promoting the exchange of scientific knowledge while educating a new generation of leaders prepared to transform the world through their contributions to the wellbeing of humanity.

The inspiration through which Francisco has profoundly enriched my mission will continue to shape this mission's trajectory and goal to make my accomplishments convergent with and reinforcing his living legacy. The art collection that nourished and intertwined our professional passions and humanitarian aspirations—and the donation of which, upon my passing, to Comillas University I reaffirm today—will emblematize this convergence. And there is another role this collection has the capacity to play, in the spirit of Francisco's and my shared aspiration to build bridges across disciplines, sectors, and nations. It has the capacity to become a pillar of a highly symbolic and inspirational transnational bridge that would uniquely reveal, perpetuate, and augment Francisco's multifaceted legacy in its entirety.

Last November, I was honored to be a guest, at Dr. Robert Hauser's invitation, at the Autumn General Meeting of the distinguished American Philosophical Society (APS). The Society is a preeminent legacy of its founder, Benjamin Franklin, one of the founding fathers of the United States. One of the Society's key missions is to "serve scholars through a research Library of manuscripts and other collections internationally recognized for their enduring historic value."[2] These include such jewels as Jefferson's handwritten, anti-slavery draft of the Declaration of Independence and Benjamin Franklin's annotated first printing of the U.S. Constitution. Francisco treasured the honor of being an elected APS member—and I treasure the honor of Francisco's papers now

[2] https://www.amphilsoc.org/about

being part of the Library's priceless collection—. I was overwhelmed with emotion when, accompanied by David Gary, Associate Director of Collections at the Library & Museum, I had the privilege of being reunited with Francisco's manuscripts, letters, and other testimonies to his professional life's journey (some 200 linear feet of them) that will be preserved forever.

Our art collection is an essential complement to the understanding of Francisco Ayala's creativity, of the intellectual nourishment he drew from art, of his profile as a complete human being. This complementarity has ignited my vision of a unique, entirely symbolic yet immensely inspirational bridge between the American Philosophical Society and the Comillas Pontifical University as the guardians of two inseparable parts of this great man's immortal legacy—legacy that will be accessible to scholars in its complexity and in its far-from-fulfilled potential to chart environmentally and socially transformative paths towards using knowledge to benefit all of humanity.

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Los territorios de la ciencia y la religión

Peter Harrison

Cuando se nos presenta el conflicto entre ciencia y religión da la sensación de tratarse de una confrontación inevitable desde el comienzo de los tiempos. Sin embargo, el dilema es relativamente reciente -apenas se originó hace trescientos años- . Y también aparente, puesto que la lucha de estas dos categorías que empleamos restringen nuestra comprensión de cómo el estudio formal de la naturaleza se relaciona con la actitud religiosa ante la vida.

En este nuevo libro, Peter Harrison desarma lo que creemos saber acerca de la ciencia y la religión, para luego volverlo a armar en una perspectiva nueva, realmente provocadora y productiva.

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