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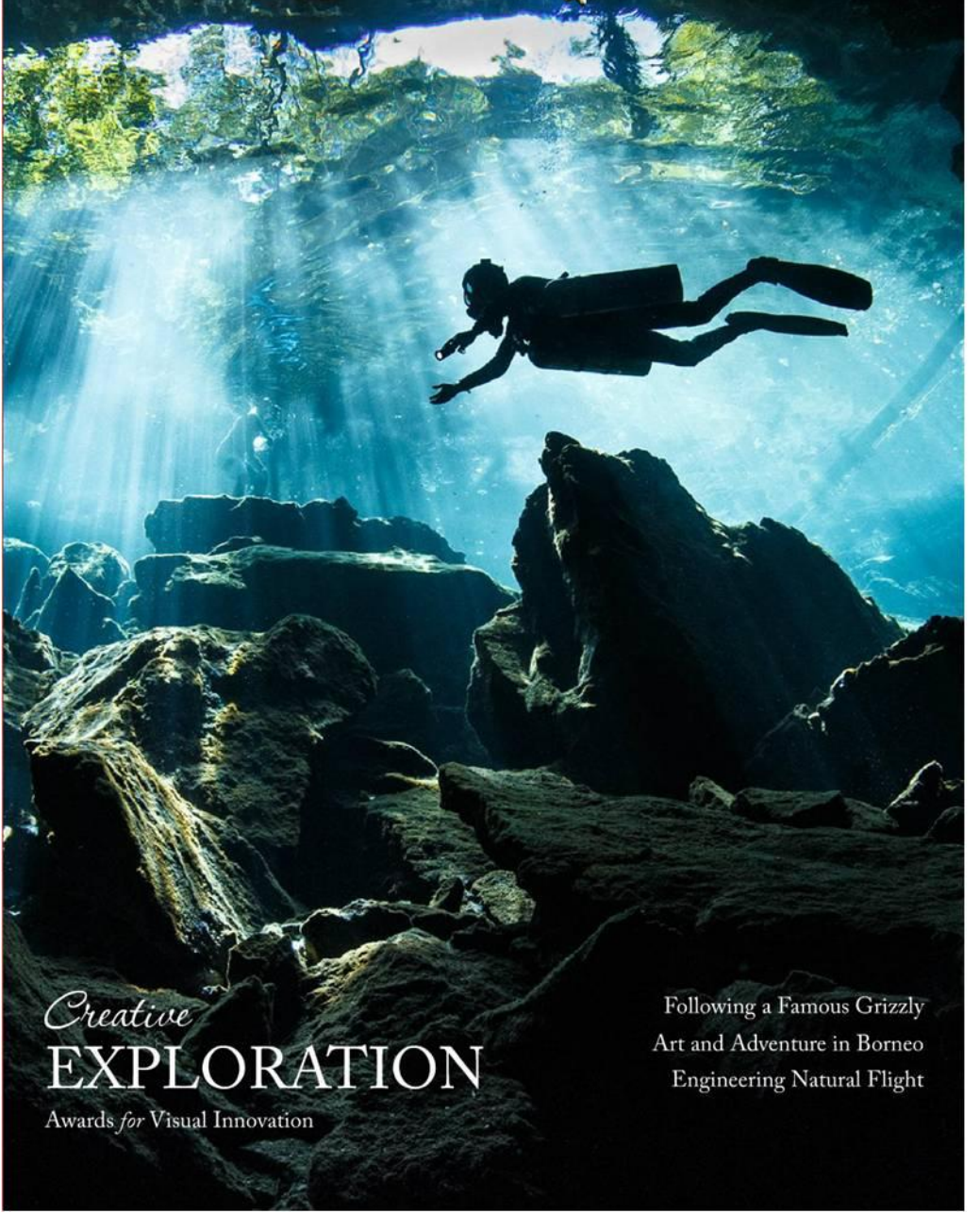

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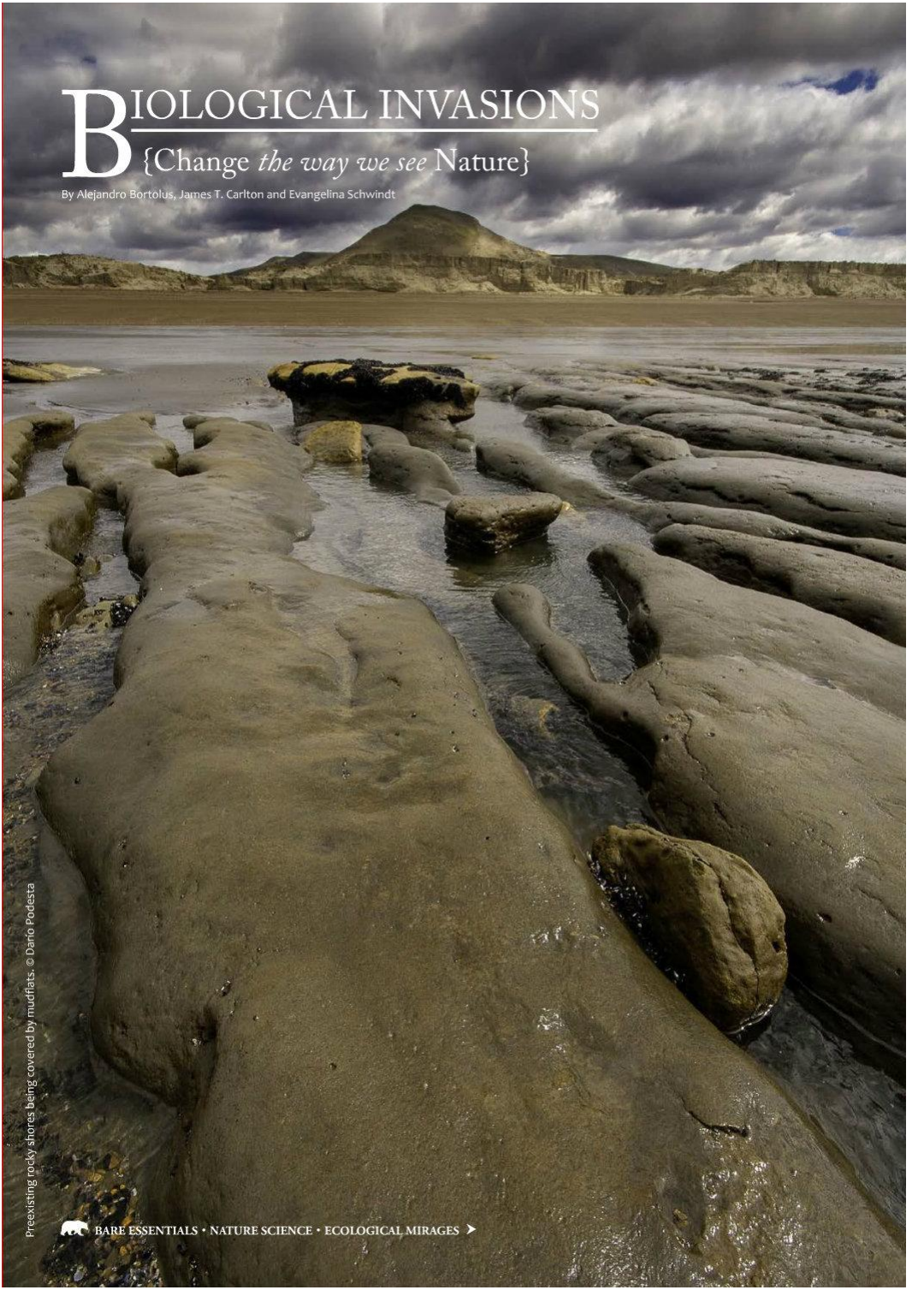
BIOLOGICAL INVASIONS

{Change *the way we see* Nature}

By Alejandro Bortolus, James T. Carlton and Evangelina Schwindt



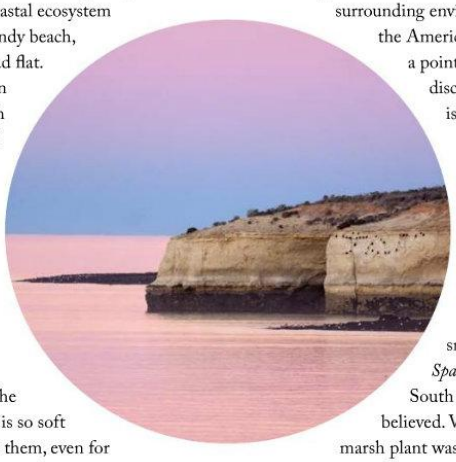
Preexisting rocky shores being covered by mudflats. © Dario Podesta

Intertidal complex. © Darío Podesta

Even our most trusted perception of Nature is not infallible; in fact it can easily be completely illusory, a condition we call Ecological Mirage, or *Espejismo Ecológico* in Spanish. A long overlooked historical event—where an exotic species is introduced to a given region but then mis-interpreted for centuries as native—may reveal unexpected radical shifts in the evolution of the affected ecosystems as they have progressed to their current state. This means that even those landscapes deeply associated with the culture and history of a region, even those our grandparents told us about, or heard about when they were young, might not be as pristine as we were led to believe. The Ecological Mirage hypothesis opens a completely new window of perceptions and perspectives permitting us to observe Nature with refreshing lucidity.

"Our ability to see, perceive and understand a masked landscape is strongly related to our ability to discover historical shifts and, concomitantly, traces of what once was."

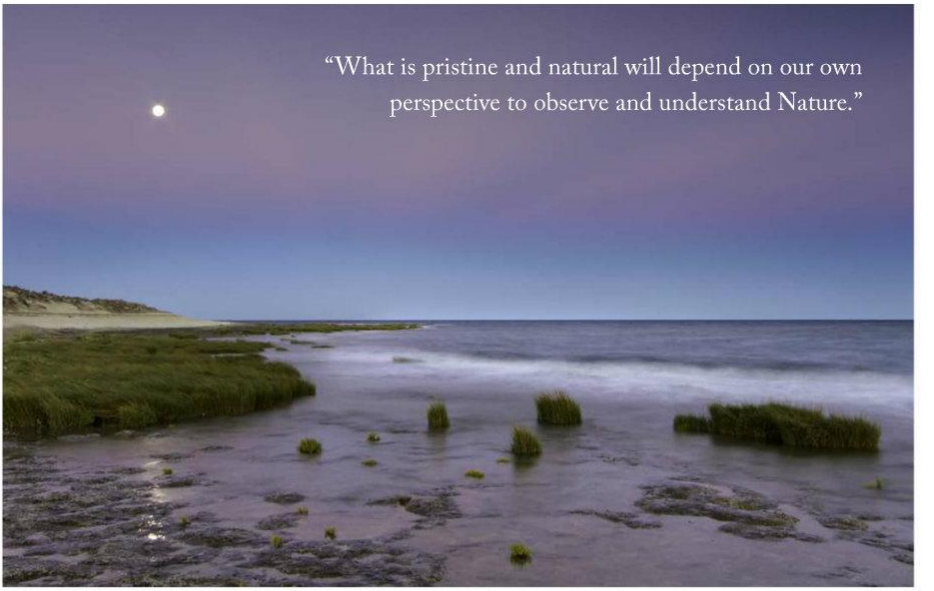
Let's start by considering the ecosystem we used to propose this hypothesis: the salt marshes of the Americas. The marsh landscape is inspiring and soul tranquilizing. Without the assistance of any electronic device, anybody contemplating a quiet afternoon in the marsh will be able to hear, touch, see, smell and even taste a variety of animals depending on, and living within, a matrix of very particular kinds of flowering plants that tolerate the rising ocean tides that overflow the entire system on a daily basis. These marshes are dominated by a small group of species that create three-dimensional structure supplying refuge, matting and nesting sites, nutrients, and substrate to the entire system. Without these plants biodiversity would be radically different: these plants are the very foundation of the ecosystem, producing a unique assemblage of plants and animals. A complete different coastal ecosystem would be a mangrove forest, a sandy beach, a rocky shore or an intertidal mud flat. The latter habitat is also common along the Atlantic coast of South America, where vast expanses of intertidal lands are formed by bare muddy substrates. Charles Darwin in the *Voyage of the Beagle* described Argentina's Bahia Blanca in 1833 as a ".... wide expanse of water (which) is choked up by numerous great mud-banks, which the inhabitants call *Cangrejales*, or crabberies, from the number of small crabs. The mud is so soft that it is impossible to walk over them, even for the shortest distance." There are places in Argentina where the tide rises up to 14 m over lands with little slope, forming mud flats of several kilometers when the tide lowers. It is a fascinating ecosystem that seems to reach to the horizon and where a person can easily wander lost for hours. A unique fauna including deposit feeder marine worms, burrowing crabs, shrimps, fish and birds characterize and differentiate this environment from a salt marsh. If you picture a landscape like that in your mind, and then imagine all that vast bare mud flat being covered by dense green grasses, then you will have a good idea of what Ecological Mirage means.



How can a "new" landscape mask the original—but overlooked and now forgotten—previous landscape? It's often a matter of spatial and temporal perspectives: Our ability to see, perceive and understand a masked landscape is strongly related to our ability to discover historical shifts and, concomitantly, traces of what once was. In cases such as the marshes we studied, these traces were mostly hidden deep in older literature scattered through many fields of endeavor. We found that travel diaries and logs, military scouting reports, railroad companies' reports, family letters, old records and original specimen collections made by the first people exploring a given place have huge historical value—often far more than formal scientific papers. During our study we even went through several church reports describing the life style of the first settlers and the surrounding environments of coastal cities across the Americas. As a scientist you may reach a point where you realize that the discipline called Historical Ecology is fundamental to our ability to understand the past, and where thinking inter-disciplinarily is not an option.

Our original scientific article* presents a detailed compilation through multidisciplinary eyes that support the conclusion that the smooth salt marsh cordgrass *Spartina alterniflora* is not native to South America, as has been long believed. We discovered that this iconic marsh plant was introduced by merchant ships from Europe and North America releasing their ballast in southern South America more than 200 years ago. Our study has revealed that what we now realize is the largest invasion by this cordgrass anywhere in the world—and one of the top ten most studied invasive species worldwide—happened right in front of our eyes but went overlooked for nearly two centuries!

Macrotidal systems supply a variety of ecosystems piled at specific tide heights. © Darío Podesta



T: Sandy shores formed on top of rocky shores in the Monte Leon National Park. B: Spartina colonizing the mud flat. © Darío Podesta

"The biodiversity on the shores of Patagonia still remains largely unknown to scientists, mysterious and challenging."

Historically devoid of the dense meadows that now characterize these ecosystems, the introduction and regional expansion of the smooth cordgrass must have caused vast shifts in bird, fish, and invertebrate biodiversity and abundance, and immense shifts in algal *vs.* detritus production, with the concomitant trophic cascades that these changes imply. These kinds of habitat modifications and community cascades have been systematically observed worldwide where this aggressive species was known to be introduced in the 20th century. Ecologists from the USA (Pacific coast) and China have recorded astonishing habitat shifts produced by the smooth cordgrass after only 50 years of its introduction, leaving us to consider the potential extent of seascape alterations that occurred in over 200 years in South America.

The importance of our work is not to simply add one more name to the list of introduced species of the Atlantic coast of South America. Rather, our results speak directly to how we perceive what we believe to be "natural" ecosystems. For two centuries, the international scientific community was unaware of the fact that coastal marshes of South America, their ecological structure and their landscape physiognomy, were an illusion, a mirage preventing us from seeing and understanding the pre-existing ecosystems. How often has this happened and where, across the planet? What this discovery tells us is that, without question, other landscape—and seascape-altering species were introduced by humans around the world centuries ago, but are now erroneously interpreted as 'native' species. This conclusion should strongly motivate scientists, environmental managers, and people in general, to seriously reconsider what we assume to be native ecosystems, and thus what we are protecting and why. The beauty of South American salt marshes is not diminished now that we know their origin, but knowing their historical roots, as it were, will critically help scientists, conservationists, and regulators to improve and strengthen future strategies to protect native biodiversity and prevent other environmental alterations.

For many years in the past, ships used to load solid ballast in order to control and dominate ship flotation and stability. Solid ballast was basically everything hard and heavy they could find along the coast, such as rocks and virtually anything associated with them, including seeds, plant fragments and small animals which were then transported long distances by these ships from port to port and across the oceans. We can no longer ignore the massive effect of human alterations worldwide—of, in this case, moving potentially 100s, or perhaps 1000s of animals and plants for centuries around the world—and resign ourselves to study what may be ecological mirages for the rest of our lives. We must incorporate the idea that many current ecosystems, even those distant and remote, are more likely than not to have been historically altered by human intervention. We can no longer assume that by simply ignoring the deeper historical role of humans in the "natural" world that we can rest comfortably and believe that what we watch, appreciate, and study, was never touched by the "hand of man."

*Bortolus, A., J.T. Carlton and E. Schwindt. 2015. Reimagining South American coasts: unveiling the hidden invasion history of an iconic ecological engineer. *Diversity and Distributions* 21 (11) 1267-1283.