

Beyond the comfort zone: *Lagenophora* Cass. (Astereae) in the Malvinas/Falkland Archipelago

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ABSTRACT

Lagenophora, a small genus within the Compositae family, captivates researchers with its intriguing characteristics. Its tiny size, lack of a pappus, and transpacific distribution on islands in the southern hemisphere are very unusual. Nowadays, *Lagenophora* comprises ca. 17 species, and its phylogenetic complexity hints at a more intricate evolutionary history. It inhabits Australia, New Zealand, Southeast Asia, India, and South America. Birds, due to sticky glands present on the fruits, may have aided in *Lagenophora*'s dispersal, although other vectors probably also played a role. The process of colonizing diverse habitats, especially remote islands, remains an enigma. Exploring continent-island biotic exchanges motivated a 2023 expedition to the Malvinas/Falkland Islands to collect insects, arachnids, and vascular plants. Support from FONCYT, Argentina, and a collaboration with SAERI were crucial for the success of this expedition. We found *L. nudicaulis* in dwarf shrub heath and montane vegetation. Although it is not a generalist plant, it has been also found in other habitats which unravels successful arrival and settling in the islands.

Keywords: Asteraceae, arachnids, biotic exchange, Compositae, islands

INTRODUCTION

The Compositae family, which is the most species-rich among vascular plants, has developed various adaptive strategies throughout its evolution, leading to successful diversification. Doubtless, the traditional dispersal structure, the pappus, is one of them. A significant number of species within this family have successfully colonized diverse environments, thanks to the dispersal opportunities generated by the diversity of forms that the pappus has evolved into. However, there is a small group of genera that deviates from this rule: the species where the pappus is absent. These particular species have captivated researchers who have proposed different theories concerning their dispersal and current distribution, particularly on islands (e.g., Carlquist, 1967, 1983; Swenson & Bremer, 1997).

Lagenophora Cass., a small genus within the Astereae tribe, holds interest for researchers due to its characteristics. Made up of petite herbaceous plants, *Lagenophora* distinguishes itself by the absence of a pappus and sticky fruits. Adding to its uncommon nature, this genus showcases a transpacific distribution, predominantly inhabiting islands in the southern hemisphere.

These unusual features and, its affinity for remote islands, have piqued the curiosity of scientists, prompting them to explore the evolutionary history, adaptive strategies, and events that could have shaped its transoceanic distribution.

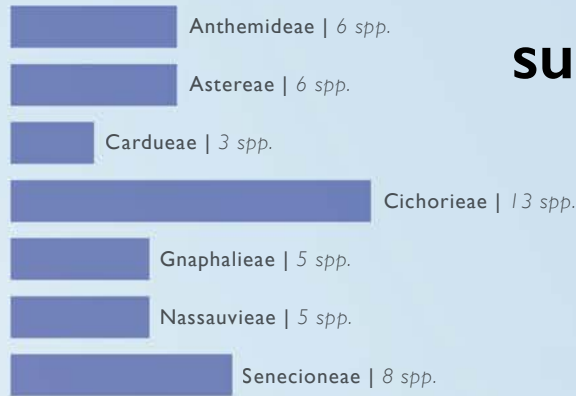
Phylogenetic studies on *Lagenophora* have revealed that the genus is paraphyletic, indicating its

From Mount Williams to Mount Tumbledown

Climbing a mountain can always be a challenge. This time we also had to deal with deep emotions. The sound of the wind was not the only one echoing in our ears. Yes, the mind can be tricky... this time the sound of the wind was the only one up there.

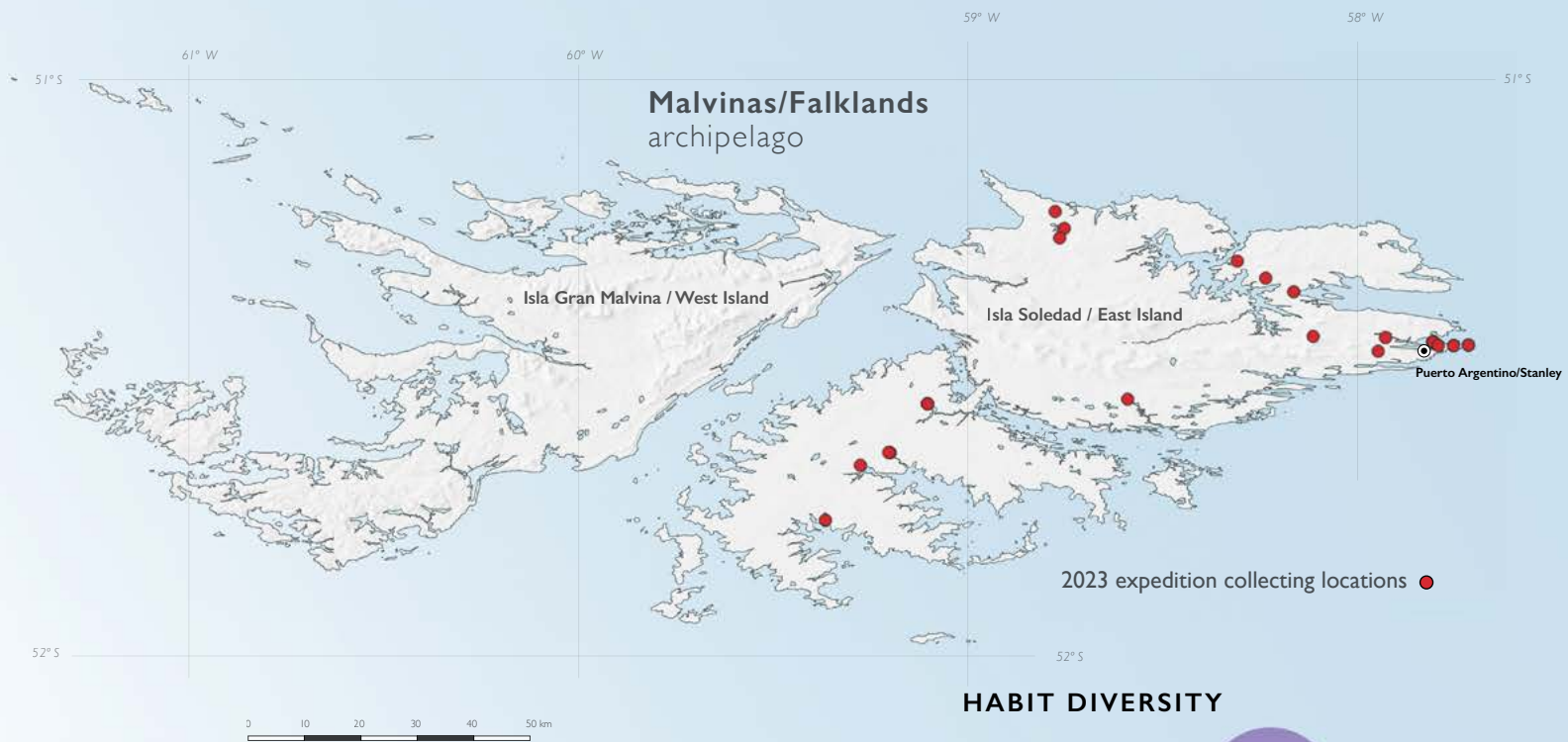
Hike from Mt. Williams to Mt. Tumbledown, Isla Soledad/East Island
Photo by M.J. Ramírez.

TAXONOMIC DIVERSITY



Map of 2023 expedition & summary of the Compositae of the Malvinas/Falkland Archipelago.

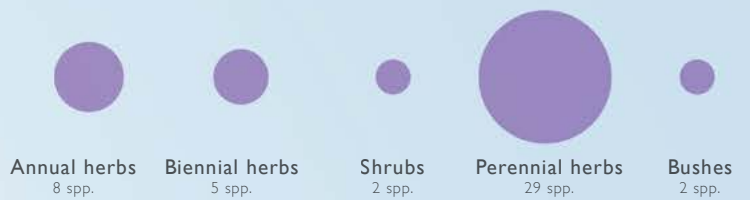
Totalling 46 species between natives and introduced, the Compositae are the most species rich family in the archipelago. Out of a total of 14 endemic vascular plant species, the Compositae with 9 endemic species, account for 64 % of them.



Diversity data was extracted and processed from Heller et al. (2019)



HABIT DIVERSITY



ORIGIN



Occasional but not Invisible

Lagenophora nudicaulis (Comm. ex Lam.) Dusén, a beautiful, tiny plant emerging from the crowded *Sphagnum* surroundings. With its white capitula turning pink and even purple with time, this species has conquered some of the most beautiful environments in southern South America.



Gordon Island, Alberto de Agostini National Park, Chile.
Photo by Mauricio Bonifácio



Figure 1. Plant collecting in Mount Tumbledown. Understanding the community composition provides the context essential for uncovering the knowledge of the individual species we seek. *Photo: M. J. Ramírez.*

evolutionary relationships are more complex than initially thought (Nakamura et al., 2012; Sancho et al., 2015). This genus currently encompasses ca. 17 known species and inhabits various continents (Wang & Bean, 2016). The highest diversity of *Lagenophora* is found in New Zealand, yet it also lives in Australia. Moreover, a few species are scattered across Southeast Asia and India, highlighting their adaptability to different environmental conditions. *Lagenophora* also occurs in South America, where three species are currently documented. These three species form a monophyletic group with an estimated divergence time of around 4.6 ma (Sancho et al., 2015). These findings offer valuable insights into the historical biogeographic events that shaped *Lagenophora*'s distribution, especially because

Antarctica might have played a significant role in the dispersal of *Lagenophora* to South America before complete formation of the Antarctic ice shield. *Lagenophora*'s South American species have a continental distribution, spanning regions in Chile and Argentina, as well as various islands, including Tierra del Fuego Archipelago, Isla de los Estados, Juan Fernández Archipelago, Malvinas/Falkland Archipelago, Tristan da Cunha and Gough Islands.

With their lack of pappus and their fruits equipped with sticky glands, birds have been suggested as potential dispersal vectors for *Lagenophora* (Cabrera, 1966), although other animals likely contribute to this process as well. Furthermore, Sancho et al. (2015) suggested that the secretion from the fruit

Table 1. Compositae of the Malvinas/Falkland Archipelago, extracted from Heller et al. (2019). AH: annual herb, B: bush, BH: Biennial herb, PH: perennial herb, S: shrub.

Tribe	Species	Status	Habit
Anthemideae	<i>Achillea millefolium</i> L.	Introduced	PH
	<i>Leptinella scariosa</i> Cass.	Native	PH
	<i>Leucanthemum vulgare</i> Lam.	Introduced	PH
	<i>Matricaria discoidea</i> DC.	Introduced	AH
	<i>Tanacetum vulgare</i> L.	Introduced	PH
	<i>Tripleurospermum maritimum</i> (L.) W.D.J.Koch	Introduced	PH
Astereae	<i>Baccharis tricuneata</i> (L. f.) Pers.	Native	S
	<i>Bellis perennis</i> L.	Native	PH
	<i>Chiliotrichum diffusum</i> (G. Forst.) Kuntze	Native	S
	<i>Erigeron incertus</i> (d'Urv.) Skottsb.	endemic	PH
	<i>Lagenophora nudicaulis</i> (Comm. ex Lam.) Dusén	Native	PH
	<i>Symphotrichum vahlilii</i> (Gaudich.) G.L.Nesom	Native	PH
Cardueae	<i>Carduus tenuiflorus</i> Curtis	Introduced	BH
	<i>Cirsium arvense</i> (L.) Scop.	Introduced	PH
	<i>Cirsium vulgare</i> (Savi) Ten.	Introduced	BH
Cichorieae	<i>Agoseris coronopifolium</i> (D'Urv.) Chambers ex D.M. Moore	Native	AH
	<i>Crepis capillaris</i> (L.) Wallr.	Introduced	AH
	<i>Hieracium antarcticum</i> d'Urv.	Native	PH
	<i>Hieracium patagonicum</i> Hook. f.	Native	PH
	<i>Hypochaeris arenaria</i> Gaudich.	Native	PH
	<i>Hypochaeris radicata</i> L.	Introduced	PH
	<i>Leontodon hispidus</i> L.	Introduced	PH
	<i>Pilosella aurantiaca</i> (L.) F.W.Schultz & Sch.Bip.	Introduced	PH
	<i>Pilosella officinarum</i> F.W.Schultz & Sch.Bip.	Introduced	PH
	<i>Sonchus asper</i> (L.) Hill	Introduced	AH
	<i>Sonchus oleraceus</i> L.	Introduced	AH
	<i>Taraxacum gilliesii</i> Hook. & Arn.	Native	PH
	<i>Taraxacum officinale</i> G. Weber ex F.H. Wigg.	Introduced	PH
Gnaphalieae	<i>Chevreulia lycopodioides</i> (D'Urv.) DC.	endemic	PH
	<i>Gamochaeta americana</i> (Mill.) Wedd.	Native	BH
	<i>Gamochaeta antarctica</i> (Hook. f.) Cabrera	endemic	BH
	<i>Gamochaeta malvinensis</i> (H. Koyama) T.R. Dudley	Native	PH
	<i>Helichrysum luteoalbum</i> (L.) Rchb.	Introduced	AH
Nassauvieae	<i>Leucheria suaveolens</i> (d'Urv.) Speg.	endemic	PH
	<i>Nassauvia falklandica</i> Upson, R. and Hind, D.J.N	endemic	B
	<i>Nassauvia gaudichaudii</i> (Cass.) Cass. ex Gaudich.	endemic	PH
	<i>Nassauvia serpens</i> d'Urv.	endemic	PH
	<i>Perezia recurvata</i> (Vahl) Less.	Native	B
Senecioneae	<i>Abrotanella emarginata</i> (Cass. ex Gaudich.) Cass.	Native	PH
	<i>Senecio candidans</i> DC.	Native	PH
	<i>Senecio littoralis</i> Gaudich.	endemic	PH
	<i>Senecio squalidus</i> L.	Introduced	PH
	<i>Senecio sylvaticus</i> L.	Introduced	AH
	<i>Senecio vaginatus</i> Hook. & Arn.	endemic	BH
	<i>Senecio vulgaris</i> L.	Introduced	AH
	<i>Tussilago farfara</i> L.	Introduced	PH

Kiting in the air

Spiders use silk threads to take lift in the wind and travel long distances, colonizing even remote oceanic islands. Is this the way many of them arrived here? Maybe the sticky yellow traps will help us to get answers.



Puerto Argentino/Port Stanley surroundings, Isla Soledad/East Island
Photo by G. Sancho.



Figure 2. Reaching the summit. We looked for different environment searching for target species. The grasslands on the slopes gave way to rocky outcrops towards the top. Photo: M. V. Lencinas.

glands could aid in buoyancy, facilitating dispersal to new territories. These unique features have allowed *Lagenophora* species to successfully thrive in the understory of southern beech forests, while they also find a home in peat bogs or dwarf shrublands. According to Sancho et al. (2015), the ancestral habitat of *Lagenophora* species is the understory of beech forests, revealing a connection to its past environment.

Nonetheless, the process of colonization into diverse habitats, particularly remote islands, remains an enigma. Questions arise as to how *Lagenophora* in South America ventured away from its “comfort zone” of beech forests and managed to establish itself in other environments. Understanding the relationship between continental and island populations is a crucial aspect of *Lagenophora*’s biogeographic evolution. These inquiries served as strong motivations for ongoing research on the biogeography of *Lagenophora* in South America (Sancho et al., in prep.).

To figure out *Lagenophora*’s story, a thorough sampling across the whole distribution area seemed like the right approach and thus the collection of specimens from both continental and island

populations of *Lagenophora* species started more than a decade ago. Through the collaborative efforts of various researchers led by G. Sancho and colleagues, including J. Mauricio Bonifacino, Laura Iharlegui, and Anabela Plos, among others, several collecting expeditions were planned. Contributions from other researchers, such as Andrea Raya Rey on Isla de los Estados and Rosa A. Scherson-Vicencio and Héctor Gutiérrez on Juan Fernández Archipelago, further enriched the sampling efforts. The remote and challenging conditions of Gough and Tristan da Cunha islands have made specimen collection an elusive endeavor. Nevertheless, near mainland southern South America, close islands crucial for comprehending the continent-island relationships in *Lagenophora*’s distribution remained unexplored: the Malvinas/Falkland Archipelago.

THE MALVINAS/FALKLAND EXPEDITION: IN THE BEGINNING

Among the three South American species of *Lagenophora*, namely *L. hariotii* Franch., *L. hirsuta* Poepp. ex Less., and *L. nudicaulis* (Lam.) Dusén,

Treasures among rocks

The rising rocks provide shelter to different communities of precious small plants and animals that we try to discover. The humid ground and shade provided by rocks show us a world of species escaping the full sun exposure.



Mt. Tumbledown, Isla Soledad/East Island
Photo by M. J. Ramírez.



Figure 3. Processing the treasures. At night, the work continues to register every detail of the long day. *Photo: M. J. Ramírez.*

only the latter is found on the Malvinas/Falkland Archipelago. An earlier attempt to collect this species during an enthralling previous trip in 2019, led by Rosa A. Scherson-Vicencio, Daniel Sziklai G., and Gisela Sancho, unfortunately proved unsuccessful. Adding to the complexity, the challenges posed by the Covid-19 pandemic further hindered access to materials collected by Stefanie Carter in the islands, underscoring the need for a new expedition to the archipelago.

This field trip held profound significance, not only for the biogeographic study of *Lagenophora* but also as an opportunity to better understand the evolution of the entire South American biota with continent-island distribution. MaríaVanessa Lencinas, Martín J. Ramírez, and Gisela Sancho, all of us researchers of Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), teamed up in planning an expedition to the Archipelago. With financial support by the Argentinean Ministerio de Ciencia, Tecnología e Innovación (MINCyT), we organized a comprehensive trip that focused on three fundamental objectives: 1) to collect insects

and arachnids, 2) to collect vascular plants, and 3) to analyze the plant communities at the collecting locations.

FROM THE FIELD

The expedition took place in January 2023 involving collections first in the Malvinas/Falkland Archipelago and later in southern Chile, around Punta Arenas.

While in the Islands, the success of the expedition would not have been possible without the collaboration of South Atlantic Environmental Research Institute (SAERI) and its director, Dr. Paul Brickley. SAERI played a pivotal role, as their helpful staff assisted us in planning the expedition. Given the challenging terrain, a 4x4 vehicle was needed, as the island roads were generally in good condition, but the topography posed its complexities. However, we faced restrictions, as the rented vehicles were prohibited from straying off the designated roads. This limitation exists because all the remaining

Step by step, a succession of wonders

In Cape San Felipe/Pembroke, a succession of environments unfolds before us, stretching from the heart of the land to the vast expanse of the sea. From grasslands to peatbogs, all connected by meandrous creeks, to the sea and beyond.

Cape San Felipe/ Pembroke, Isla Soledad/East Island
Photo by M. J. Ramirez



Figure 4. Pressing in the field saves time and mistakes. *Photo: M. J. Ramírez.*

road infrastructure in the archipelago is exclusively reserved for residents living on the islands. Unfortunately, reaching Gran Malvina/ West Falkland Island demanded a different logistical approach and more time than our schedule allowed.

As is customary in any field trip, our daily activities started early, allowing us to maximize our time. The 4x4 vehicle quickly became our trusted ally, even though navigating on the left side of the road was not exempt of challenges for us. Departing the town of low houses and beautiful gardens, the immensity of the landscape overwhelmed our senses. On one side, the serene and chilly sea stretched as far as the eye could see, while on the other, the vast expanse of golden terrain with rolling hills seemed to continue endlessly to the horizon. The absence of trees did nothing to diminish the beauty of our surroundings. Throughout our journey, we encountered a diverse array of environments, often characterized by imposing rock formations that dramatically shaped the landscape (Figure 1). Some scenes before us were unlike any other, like the characteristic gray rock rivers flowing gracefully down the mountains, intermingling with the

golden grass (Figure 2) and green dark heathlands of dwarf shrubs and ferns (Figure 4). Some other places reminded us of the landscapes and biotic connections shared with other places like Tierra del Fuego (Figure 7). Setting foot on those hills evoked profound emotions within us.

We were impressed by the unusual characteristics of the ground that was draped in peat, making every step a challenge. Beneath the surface, inconspicuous streams meandered, concealed by the lush vegetation. Enigmatic circles of varying diameters, seemingly carved into the peat, form dark lagoons with depths that remained mysterious. The presence of vast fern expanses between the rocks served as a signature feature of the islands.

In other areas, the expansive prairie seemed to sway in harmony with the wind, its grasses displaying a vibrant range of colors from golden to crimson (Figure 5). Elsewhere, the striking contrast of the blue-green sea, fine white sands, and light green tussac grass dominated our view.

A sea of grass

Grasslands in Malvinas/ Falkland Islands encompass acid, neutral (including “Greens”), and improved and reseeded grasslands (Heller & al., 2019).

Horseshoe Farm, Isla Soledad/East Island
Photo by Gisela Sancho

The world of the minuscule: searching for the continental relatives

The answers not always are blowing in the wind. The ground offers a world of hints on the continental-island biota connections. With our collections from Malvinas/Falklands Islands in mind, here, we screen a peatbog in southern Chile.

Laguna El Parrillar Park, Punta Arenas, Región Magallanes, Chile.
Photo by G. Sancho.

White is not the absence of color

In Gypsy Cove, some landscapes of the islands are stunning by their contrasts. Here, the white sand intermediates between the sky and the sea.



Gypsy Cove, near Puerto Argentino/ Port Stanley, Isla Soledad/East Island
Photo: G. Sancho.



Figure 5. The blue sky in the islands can rapidly turn into gray sky indicating the work day is coming to a close.
Photo: G. Sancho.

As usually we focused on the tiny wonders of plants and spiders, unaware of another world, of other beings that were unnoticed to us. These are the penguins with their gracious chicks nesting among the tussock grass. That's how we are, passionate about tiny things, so soon we looked at the ground again.

During the trip we realized something unusual, making the whole scene almost out of place, not in harmony with the landscape. This place should have been predominantly, if not entirely, moist, yet as we walked, instead of sinking our feet into soft ground, we felt a disheartening crunch underfoot. The past few years have been unusually dry, and the effects of climate change are becoming evident. Despite the hospitality of one resident, who drove us to cover much more ground with the vehicle than we could on foot, finding

humid environments with *Lagenophora* was no longer a simple task. This unfortunate trend is mirrored in mainland southern South America, with growing concerns about its impact, for instance, on livestock. Whether due to climate phenomena, climate change, or a combination of factors, drought is wreaking havoc and reshaping the landscape.

Yet, amidst these somber reflections, the breathtaking red sunsets granted us a brief respite. Later, we had to process and preserve the precious specimens we had collected, cherishing them as invaluable treasures from our journey (Figure 3).

During our expedition to Isla Soledad / East Falkland Island, we visited a total of 28 locations (see map). In each of these sites, we collected specimens of

Nature's design

Nature, the master landscape designer, achieves in a single brushstroke wonders that humans can never replicate. This truth becomes evident as we immerse ourselves in the community of *Senecio candidans* DC.

Yorke Bay, Isla Soledad/East Island
Photo by M. Ramírez.

insects and arachnids, and in 22 of them, we also gathered vascular plants. At nine selected sites, we conducted environmental characterizations, considering impact types, ground and vegetation cover, and plant species richness.

To ensure the valuable specimens of vascular plants were well-documented and accessible for research, duplicates were distributed to several herbaria, including the Museo de La Plata (UNLP), Centro Austral de Investigaciones Científicas (CADIC, CONICET), Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN), Falkland Conservation Institute, Instituto de la Patagonia, and the Government of Tierra del Fuego.

To gather arachnids and insects, we employed a variety of methods, including manual collection, Berlese funnels, and sticky traps. We are also collaborating with Alastair Lavery, a researcher that spent many years studying arachnids from the Islands. Currently, the collected organisms are being processed, ensuring that their scientific value is preserved and that they will contribute significantly to our research findings.

LAGENOPHORA NUDICAULIS: OCCASIONAL BUT NOT INVISIBLE

Spotting *Lagenophora* wasn't an easy task; its size doesn't exceed two centimeters in height (Figure 6). Nevertheless, there it was—occasional but not invisible—with its small heads of white or pinkish corollas, indicating the passage of time. After years of searching in the understory, identifying *L. nudicaulis* habitat in the Malvinas/Falkland Islands proved to be a challenge. However, certain characteristics remained consistent: moist areas with loose, organic-rich soil. As usually happens to botanists, once we gain sense of a search image, everything fell into place. Among the fourteen proposed habitat types for the islands (Heller & al., 2019), this plant thrives in inland rock, dwarf shrub heath, greens and natural grasslands, acid grasslands, and coastal cushion heath.

As one of the 34 native species of Compositae (Table 1) on the islands, *Lagenophora nudicaulis* offers a



Figure 6. Sterile *Lagenophora nudicaulis* (Comm. ex Lam.) Dusén is even more difficult to find than the blooming one, but a careful scrutiny of the ground reveals her among its companions (*Empetrum rubrum* Vahl ex Willd., *Pernettya pumila* (L. f.) Hook., *Blechnum penna-marina* (Poir.) Kuhn) in a heath community. Photo: M. V. Lencinas.

historical connection with mainland South America. Besides, many of the communities, with their familiar appearance and composition, mirror habitats found on the nearby continent. While some studies have explored these connections (e.g., Kopuchian & al., 2016; Baranzelli & al., 2018), we still need to uncover the how and when of the continent-island exchange for *Lagenophora* and the other organisms inhabiting



Figure 7. Not many tall shrubs rise from the ground in the islands. Here, *Chiliotrichum diffusum* (G. Forst.) Kuntze, another witness of the continent-island connections, seems to blend with the sea and the sky. Photo: G. Sancho.

the archipelago. The task is both challenging and enthralling, and we are committed to it. As we left the islands, we were saddened to say goodbye to a place so close and familiar, yet far away, taking with us inspiring memories of its majestic landscapes and marvelous biota.

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