

ORIGINAL ARTICLE

A new species of the endemic genus *Centaurodendron* Johow (Asteraceae, Centaureinae) from Alejandro Selkirk Island, Juan Fernández Archipelago, Chile

Una nueva especie del género endémico *Centaurodendron* Johow (Asteraceae, Centaureinae) de la isla Alejandro Selkirk, Archipiélago Juan Fernández, Chile

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ABSTRACT

A new endemic species, *Centaurodendron schilleri*, is described from the Juan Fernández Archipelago, Chile. This is the third species of the endemic genus, *Centaurodendron*, which is closely related to *Plectocephalus* of the Chilean mainland. The new species is confined to Alejandro Selkirk Island, whereas the previously known species, *C. dracaenoides* and *C. palmiforme*, are confined to Robinson Crusoe Island. In morphological aspects, the new species is more distinct from the other two species than they are from each other. Molecular phylogenetic and biogeographic studies for island and continental species of these genera are in progress.

Keywords: Alejandro Selkirk Island, Centaureinae, *Centaurodendron*.

RESUMEN

Se describe una nueva especie endémica, del archipiélago Juan Fernández, *Centaurodendron schilleri*. Esta es la tercera especie del género endémico *Centaurodendron*, el que se relaciona con *Plectocephalus* de Chile continental. La especie nueva crece en la isla de Alejandro Selkirk, mientras que *C. dracaenoides* y *C. palmiforme* lo hacen exclusivamente en la isla de Robinson Crusoe. En cuanto a la morfología, las dos especies conocidas se parecen más entre sí que cada una con la nueva. Estudios filogenéticos moleculares y biogeográficos sobre el complejo del grupo *Plectocephalus* s.l. de las islas y del continente están ahora en proceso.

Palabras clave: Centaureinae, *Centaurodendron*, Isla Alejandro Selkirk.

INTRODUCTION

The Juan Fernández Archipelago is located in the Pacific Ocean, 667 km from central Chile, and it comprises two main islands, Robinson Crusoe (also known as Masatierra) and Alejandro Selkirk (Masafuera), plus a minor one, Santa Clara. This is a Chilean National Park and Biosphere Reserve, and contains a very high level of vascular plant endemism, which reaches over 64 % (Stuessy 2020). Within the fernandezian floristic elements (Takhtajan 1986, Penneckamp 2018), Asteraceae are the most diverse, containing the largest number of neoendemic genera in the archipelago with *Centaurodendron* Johow (including *Yunquea* Skottsbo.), *Dendroseris* D. Don, and *Robinsonia* DC. (Stuessy *et al.* 2017, Stuessy *et al.* 2022), encompassing twenty one species. Seventeen of these species are restricted to Robinson Crusoe Island and four occur only on Alejandro Selkirk Island. *Dendroseris* has three species on this island and *Robinsonia* only one (Danton & Perrier 2006, 2020; Stuessy *et al.* 2017), and it has been hypothesized that they derived from colonizations from congeners on Robinson Crusoe Island, followed by speciation (Takayama *et al.* 2015, 2018; Stuessy *et al.* 2017).

The evolutionary processes of these genera in the Juan Fernández Archipelago have been extensively studied, especially in *Dendroseris* (Sanders *et al.* 1987, Crawford *et al.* 1992, Sang *et al.* 1994, Cho *et al.* 2020), the continental ancestor of which is *Sonchus* L. (Mejías & Kim 2012), and in *Robinsonia* (Sanders *et al.* 1987, Takayama *et al.* 2013, 2015), which is nested within *Senecio* L. s.l. (Pelser *et al.* 2010). *Centaurodendron* appears to have originated from *Plectocephalus* D. Don (Susanna & Garcia-Jacas 2007, Susanna *et al.* 2011), a genus whose major diversification is currently in continental Chile associated with the Atacama desert and Mediterranean zone (Susanna *et al.* 2011, Penneckamp *et al.* 2020). Molecular studies with species of both genera have consistently placed in *Centaurodendron* nested within *Plectocephalus* (Susanna *et al.* 2011, Barres *et al.* 2013, Herrando-Moraira *et al.* 2019). For this reason, some authors (e.g., Hellwig 2004) have submerged the former into the latter, but based on degrees of morphological divergence, this view has been opposed by Susanna *et al.* (2011), summarized in Stuessy *et al.* (2014) and Urbina-Casanova *et al.* (2015).

In February 2009, park ranger Mr. Ramón Schiller (Fig. 1) sighted an unknown bush of the Compositae with showy purple flowers in a nearly inaccessible area at “El Tongo” ravines (quebradas) on the southwest side of Alejandro Selkirk Island. This island is located 848 km west of mainland Chile, and it is the youngest island of the Archipelago, with an

estimated geological age of c. 1 million years old (Stuessy *et al.* 1984, Stuessy, 2020, Becerril *et al.* 2021).

During several seasons of observation by park rangers, it was concluded that this plant could correspond to a new species, and in the summer of 2016, a first expedition was organized by the Fundación Endémica and Conaf (Corporación Nacional Forestal) of the Juan Fernández National Park to obtain samples of this unidentified species for further analysis, however it was not possible to obtain material from the plant due to extreme environmental conditions. A second expedition was carried out in February-March 2020, which was successful. A few additional plants were also found in a rocky ravine, where it was possible to collect enough material for study (Fig. 1). Based on morphological flowers characters, this taxon corresponds to a new species of the genus *Centaurodendron* (Johow 1896, Skottsberg 1957).

MATERIALS AND METHODS

Samples of the new *Centaurodendron* were collected in the field and deposited in SGO (Museo Nacional de Historia Natural, Chile). Comparisons were made with other herbarium material of *Centaurodendron* from SGO (acronyms following Thiers 2022) and online images of type material of *Centaurodendron* available at C (University of Copenhagen, Denmark), GB (University of Gothenburg, Sweden), NY (The New York Botanical Garden, USA) S (Swedish Museum of Natural History), and US (Smithsonian Institution, USA) on <https://plants.jstor.org> web page. Also living plants of *ex situ* culture at JBN (Jardín Botánico Nacional, Chile) were used for leaves measurements.

RESULTS

Centaurodendron schilleri Penneck., N. Garcia & Susanna sp. nov. (Fig. 2)

Type: CHILE, Region of Valparaíso, Prov. Valparaíso, Juan Fernández Archipelago, Alejandro Selkirk Island (Masafuera Island), Quebrada El Tongo, 33°47'48.564"S, 80°47'54.822"W, 375 m., 5-III-2020, Lukas Mekis, Ramón Schiller & Erick Vigouroux s.n. (Holotype SGO 170527, Fig. 3)

Diagnosis: A *Centaurodendri palmiformi* et *dracaenoide capitulis pedunculatis haud sessilis, solitariis nec non glomeratis, bracteis involucri lignosis nec non herbaceis, integerrimis nec non pectinato-fimbriatis, differt.*



FIGURE 1. (a) Park ranger Ramón Schiller herborizing samples of the new *Centaurodendron*, photograph by Lukas Mekis; (b) Collecting material for herbarium at habitat in Quebrada El Tongo, the arrow indicates the specimen; climbers: lower Lukas Mekis, upper Erick Vigouroux. Photograph by Tomas Mekis. / (a) Guardaparque Ramón Schiller herborizando muestras de la nueva especie de *Centaurodendron*, fotografía de Lukas Mekis; (b) Colecta de material para herbario en el hábitat en la quebrada El Tongo, la flecha indica el ejemplar; escaladores: abajo Lukas Mekis, arriba Erick Vigouroux. Fotografía de Tomas Mekis.



FIGURE 2. Iconography of *Centaurodendron schilleri*: (a) Branch and leaves, based on pictures of living plants at habitat; (b) Capitula and (c) Floret, based on SGO 170527 (Type). Drawn by Gloria Rojas. / Iconografía de *Centaurodendron schilleri*: (a) Rama y hojas, basado en fotografías de plantas vivas en el hábitat; (b) Capitulo y (c) Flósculo, basado en SGO 170527 (Tipo). Dibujo por Gloria Rojas.

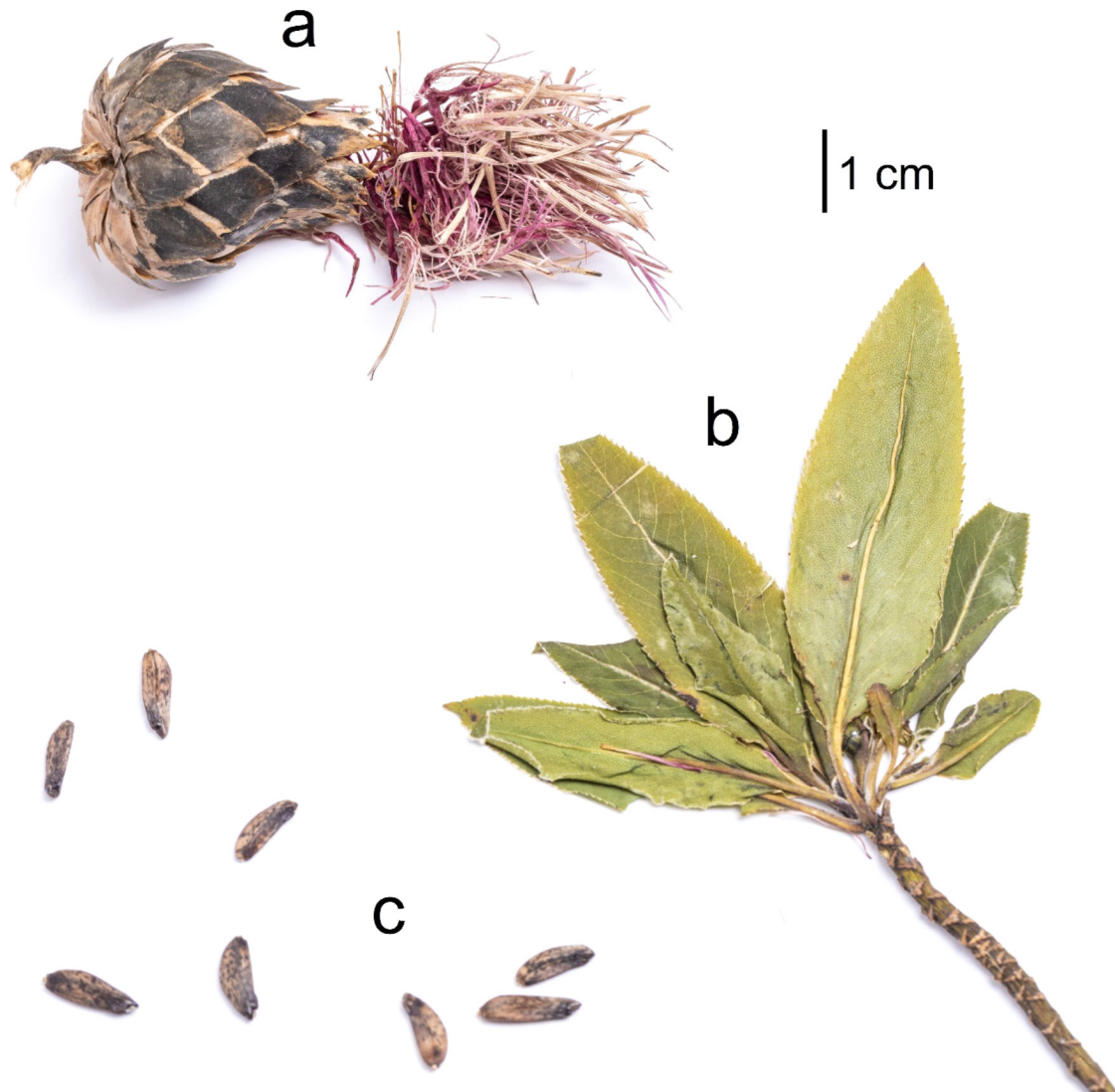


FIGURE 3. Holotype of *Centaurodendron schilleri*; (a) Branch with rosette leaves at apex; (b) Flowering mature capitulum; (c) Cypselae. Photograph by Lukas Mekis. / Holotipo de *Centaurodendron schilleri* (a) Rama con hojas arrossetadas en el ápice; (b) Capítulo maduro con flores; (c) Cipsela. Fotografía de Lukas Mekis.

Shrub ca. 1.5 m tall, with pseudodichotomous branching. Leaves arranged rosette like at the apex of the branches in mature plants. Bark beige in color. Stems glabrous, with leaves congested toward apex in a terminal rosette. Leaves simple, 2.5-14 cm long x 1-5.5 cm wide, petiolate; petioles 0.8-1.5 cm long, canaliculated. Lamina ovate-lanceolate, chartaceous, glabrous, with margin serrate. Capitula homogamous, terminal and solitary on glabrescent, striate peduncles, subtended by some very rudimentary bracts. Involucre urceolate-globose, ca. 2.5 cm diam. Phyllaries in 7-9 series, hard and lignified, glabrous, with margins entire. Internal phyllaries linear-lanceolate, 1.8-2 cm long x 2-3 mm wide, with apex acute

and sometimes mucronulate. External phyllaries ovate to ovate-lanceolate, 2-2.5 cm long x 1-1.4 cm wide. Receptacle slightly concave to flat, bristly; bristles subulate, 2.5 cm long, with margins slightly scabrous and minutely dentate. Corollas very showy, purpureous-pink to rosaceous. All florets hermaphroditic (lacking showy sterile peripheral florets), 4-5 cm long x 0.2 cm wide; corolla lobes linear, 1.5-1.7 cm long x 0.5-1 mm wide, at apex subspathulate; tube 1.5-2.3 cm long. Style ca. 3 cm long, with very short bilobed, spinulose-papillose stigmas; anthers ca. 1.5 cm long. Mature cypselae 1-1.3 cm long x 0.5 cm wide, brown mottled with black; pappus short, deciduous.

Distribution and Ecology: Part of “El Tongo” ravine vegetation (Fig. 4) is associated with the *Myrceugenia schulzei* Johow forest matrix (Greimler et al. 2013). *Centaurodendron schilleri* is found growing mainly associated with *Libertia chilensis*

(Molina) Gunckel, *Peperomia berteriana* Miq., *Gaultheria racemulosa* (DC.) D.J. Middleton, *Blechnum chilense* (Kaulf.) Mett., *Polystichum tetragonum* Fée, and *Gunnera masafueriae* Skottsbo. The nomenclature follows Rodríguez et al. (2018).



FIGURE 4. (a) *C. schilleri* in natural habitat at “El Tongo” ravine; (b) detail of a specimen; (c) branch with mature capitulum; (d) bark. Photographs by Lukas Mekis. / (a) *C. schilleri* en su hábitat natural en la quebrada “El Tongo”; (b) detalle de un ejemplar; (c) rama con capítulo maduro (d) corteza. Fotografías de Lukas Mekis.

Etymology: The name commemorates Mr. Ramón Schiller (1955), park ranger of the Juan Fernández Archipelago National Park, who discovered this new species.

Notes: This new species has a partially monocarpic habit, similar to other neoendemic species of Compositae in the

Archipelago, i.e., *Dendroseris pruinata* (Johow) Skottsberg and *Centaurodendron dracaenoides* (Skottsberg 1921). Fertile branches die after anthesis, producing new branches in the lower part of the peduncle following a typical pseudodichotomous architecture (Leeuwenberg model; Hallé *et al.* 2007).

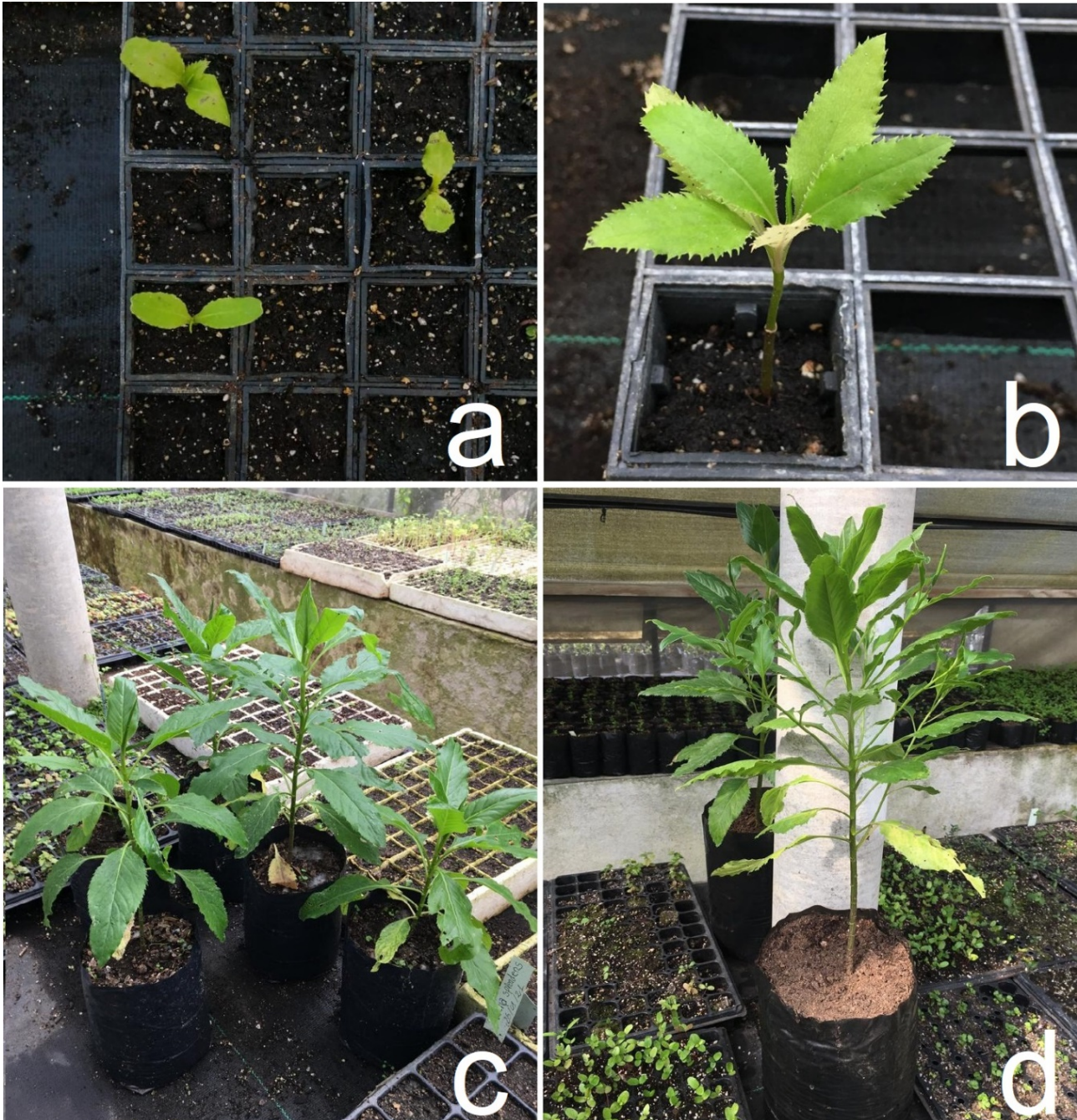


FIGURE 5. Plants of *C. schilleri* in *ex situ* culture at Jardín Botánico Nacional, Viña del Mar, Chile: (a, b) seedlings and (c, d) juvenile exemplars. Photographs by Patricio Novoa. / Plantas de *C. schilleri* en cultivo *ex situ* en el Jardín Botánico Nacional, Viña del Mar, Chile: (a, b) plántulas y (c, d) ejemplares juveniles. Fotografías de Patricio Novoa.

Conservation status: There is only one known population of this new species with less than five plants in a single locality, sheltered on a practically inaccessible rock wall. There could be more populations, but the extreme habitat of this plant makes it difficult to estimate its status. Based on IUCN (2012) criteria, its status can only be regarded as “Critically endangered” CR [B2ac(i,ii,iii,iv) + C2 a(i)b + E]. It is possible that *Centaurodendron schilleri* was more abundant in the past, its decline having been accelerated by the introduction of goats (Stuessy 2020). These feral animals are known to have negatively impacted populations of other native species on Alejandro Selkirk Island, such as the endemic shrub *Chenopodium nesodendron*, which was thought to be extinct

until two plants were rediscovered by park rangers after 58 years (Araya *et al.* 2018). A similar situation prevailed with the shrub-tree *Dendroseris gigantea*, the last known individual of which died on Alejandro Selkirk Island in 2014. Fortunately in this case, seeds had been collected by park rangers from the parent plant before it died, and with *ex situ* cultivation in the Juan Fernández National Park nursery, the species has been saved from extinction (Penneckamp 2018). In a similar fashion, seeds of *Centaurodendron schilleri* have been harvested for *ex situ* cultivation in the Juan Fernández National Park nursery on Robinson Crusoe Island, and seeds have also been sent to the National Botanical Garden of Chile, Viña del Mar (Fig. 5) and the Botanical Garden of Barcelona, Spain.

KEY TO *Centaurodendron*

1. Capitula solitary, woody phyllaries lacking appendages at apex..... *C. schilleri*
- 1'. Capitula many in corymbose inflorescence, ± herbaceous phyllaries with pectinate-fimbriate appendages at apex.....2
 2. Monocarpic and monopodic treelets, hollow stems..... *C. palmiforme*
 - 2'. Branched treelets with pseudo-dichotomy growing, solid stems..... *C. dracaenoides*

DISCUSSION

Centaurodendron schilleri shows striking morphological differences with *C. dracaenoides* and *C. palmiforme* (Table 1). The former is a shrub to 1.50 m, not treelets as in the latter; the mature heads are large and solitary, not congested in a flat-topped corymb; and the phyllaries are very hard and sclerified instead of herbaceous. In fact, the habit of the new species is quite similar to what one might consider the continental ancestor of *Centaurodendron* and *Yunquea* group within the sister genus *Plectocephalus* (Susanna *et al.* 2011).

These preliminary morphological observations lead to interesting phylogenetic and biogeographic considerations for the origin of the island endemics. Important to consider are the geological ages of the two islands: Robinson Crusoe is c. 4 million years old and Alejandro Selkirk c. 1 million (Stuessy *et al.* 2017, Becerril *et al.* 2021). It is puzzling that the morphological divergence between the two species on the older island, which has existed for 4 million years, is less than that between either of these species and the new species on the younger island, a divergence which could only have occurred within the 1 million years of the island's existence. In fact, one might even be motivated to suggest subgeneric status for the new species. If *C. schilleri* were derived out of the complex of two species on Robinson Crusoe Island, via

long-distance dispersal followed by anagenetic speciation, then one would expect the new species to be closer to one or the other of the two on Robinson Crusoe Island, not equally divergent from both. Such a pattern can be seen in *Robinsonia*. The endemic species of this genus on Alejandro Selkirk Island is *R. masafuerae* Skottsbo., and it ties very closely to *R. evenia* Phil. on the older island (Takayama *et al.* 2015). Likewise, *Dendroseris regia* Skottsbo. on Alejandro Selkirk Island is closely related to *D. berteriana* (Decne.) Hook. & Arn. on the older island (Sanders *et al.* 1987, Crawford *et al.* 1992), again suggesting dispersal followed by anagenetic speciation from identifiable progenitors.

Several hypotheses come to mind in explanation of these observed patterns in *Centaurodendron*. (1) The simplest explanation is that the two species of *Centaurodendron* speciated cladogenetically on Robinson Crusoe Island, and from out of this complex a dispersal event occurred to Alejandro Selkirk Island followed by anagenetic speciation (with strong directional selection) to yield *C. schilleri*. (2) All three species of *Centaurodendron* might have evolved cladogenetically on the older island during the past four million years, with significant divergence of *C. schilleri*, followed by its recent dispersal to the younger island (without further speciation), and with extirpation of original populations on Robinson Crusoe Island. (3) If *C. schilleri* seems

to show a closer relationship with species of *Plectocephalus* on the continent than with the congeners on Robinson Crusoe Island, then this might suggest an independent dispersal from the continent directly to the younger island during the past 1 million years. If this were the case, it would threaten the evolutionary homogeneity (monophyly) of *Centaurodendron*, rendering it evolutionarily biphyletic and undesirable taxonomically. Preliminary results of an ongoing

molecular study of both genera, however, have suggested that *C. schilleri* does indeed belong to *Centaurodendron* (Susanna *et al.* pers. comm.), which would give support to the first two hypotheses. Resolution of the precise phylogenetic and biogeographic relationships among these species must await detailed morphological comparisons and molecular analyses among all species of these two genera (now in progress, Susanna pers. comm.).

TABLE 1. Comparison among *Centaurodendron* species. / Comparación entre especies de *Centaurodendron*.

| Character | <i>C. schilleri</i> | <i>C. dracaenoides</i> | <i>C. palmiforme</i> |
|-------------------------|------------------------------|------------------------|----------------------|
| Habit | Shrub | Treelet | Monocarpic Treelet |
| Inflorescence | Solitary | Clustered | Clustered |
| Capitula | Homogamous | - | Heterogamous |
| Phyllaries | Sclerified | ±Herbaceous | ±Herbaceous |
| Appendages | Absent | Pectinate-fimbriate | Pectinate-fimbriate |
| Leaves margins | Serrate | Dentate | Dentate |
| Size at natural habitat | 1.5 m | 3.5 m | 4 m |
| Flowers color | Purpureous-pink to rosaceous | Purpureous | Purpureous |

ACKNOWLEDGMENTS

We are very grateful to: personnel of CONAF (Corporación Nacional Forestal), Juan Fernández National Park, Fundación ENDEMICA: Felipe Paredes, Carolina Bustamante; Tomas Mekis and Erick Vigouroux for their efforts to locate and collect the new species. Armada de Chile (Chilean Navy) and Transmarko shipping company by help with transport to the Islands, and community of Alejandro Selkirk Island; Rodrigo Chaura and Oscar Fernández (Jardín Botánico Nacional, Chile).

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Received: 23.02.2022

Accepted: 08.04.2022