Distribution and Variability of *Cistanthe philhershkovitziana* Hershk. (*Cistanthe* sect. *Cistanthe*; Montiaceae)

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ABSTRACT

The present work exploits internet resources to update previously reported data for the distributional range and ecology of *Cistanthe philhershkovitziana* Hershk. (*Cistanthe* Spach sect. *Cistanthe*; Montiaceae), a conspicuous and not uncommon species of central and north-central Chile. The latitudinal range documented here is at least 4.8° greater than previously reported, extending from ca. 29°S (Huasco Province, Atacama Region) to ca. 33.8°S (San Antonio Province, Valparaiso Region). Possibly it extends further north to at least ca. 28.5°S. Morphological and ecological variability is discussed.
Key words: *Cistanthe philhershkovitziana*, Montiaceae, Chile

[CITATION: Hershkovitz, M.A. 2022. Distribution and Variability of *Cistanthe philhershkovitziana* Hershk. (Cistanthe sect. Cistanthe; Montiaceae). EcoEvoRxiv. https://ecoevorxiv.org/6udn5/]

Introduction

Hershkovitz (2018a) described *Cistanthe philhershkovitziana* Hershk., (*Cistanthe* Spach sect. *Cistanthe* sensu Hershkovitz, 2019; Montiaceae), a species conspicuous and not uncommon in Chile's Valparaiso and Coquimbo Regions and observed once in the Metropolitana Region near the border with the Valparaiso Region. The species is unusual, because it is the only one that evidently is normally (always?) annual among the ca. 12 species of *C.* sect. *Cistanthe*. Hershkovitz (2018b) documented historical but misidentified collections of *C. philhershkovitziana* dating from 1829 and spanning the range between ca. 30.1–32.3°S (ca. 350 km) in Chile's Coquimbo and Valparaiso Regions.

The present work documents that the range of the species extends both further north and south, between at least ca. 29–33.8°s (ca. 550 km), and it extends into the Atacama Region. The work also demonstrates greater distributional continuity, the range interrupted mainly by urbanization and also geological idiosyncrasies. Morphological and ecological variability and evidence for anthropogenic range expansion also is discussed.

Methods

The present data was compiled mainly using internet searches for images of plants that could be diagnosed as *C. philhershkovitziana*. In addition to a general Google search, searches were conducted at internet sites that emphasize biodiversity data: GBIF (GBIF Secretariat, 2017), iNaturalist (www.iNaturalist.org); popular photographic sites: Flickr, Fotonaturaleza (www.fotonaturaleza.cl); and also social networks (Facebook, Twitter, Instagram). Because images of *C. philhershkovitziana* usually are misidentified (Hershkovitz, 2018a, b), searches were conducted using the terms *Cistanthe*, *Calandrinia* (in which *Cistanthe* historically had been classified; Carolin, 1987; Hershkovitz, 1991a, 2019), and "pata de guanaco," the last a vernacular name commonly applied in Chile to several species of *Cistanthe*.

Results

Table 1 summarizes information for 44 geographically localized observations/collections of *C. philhershkovitziana*. The records are sorted latitudinally from north to south. Longitude data is not included, because it is not informative. Included, rather, are distances inland from the shoreline.

Of these 44 records, 11 were reported in Hershkovitz (2018a, b; 2021) and 32 are newly reported here. Of these 33, 27 reports were found in iNaturalist, though only one of these was identified as *C. philhershkovitziana*. The others currently are identified as *C. grandiflora* (Lindley) Schltdl. Other records newly reported here include one new personal observation and one report each from the GBIF, Flickr, and Instagram sites, and a functional but evidently defunct commercial site (www.succulentas.com). The last record was located using the general Google search for the term "*Cistanthe*."

No confirmable records/images of *C. philhershkovitziana* were found on Twitter or Facebook, although these sites are difficult to review comprehensively. In particular, posts are sorted only by date and not by content and, moreover, scrolling from the most recent post, there seems no way stop, save your place, and continue from there later. However, all of the sources above yielded records of plants that possibly represent this species. The photographic sources often include photos of just flowers. Floral traits discriminate *C. philhershkovitziana* from some but not all species of *C.* sect. *Cistanthe*. Generally, photos of the entire plant are necessary to diagnose the species. However, in some cases, I diagnosed the species based on a floral photo plus "circumstantial" evidence, e.g. knowledge of the locality and/or other details in the photograph.

Discussion

1. Biogeography of C. philhershkovitziana

Table 1 and Fig. 2 demonstrate that the latitudinal distribution of *C. philhershkovitziana* is essentially continuous in Chile between at least 29–33.8°S, and quite likely it extends further north at least half a degree. The largest "natural" latitudinal gaps are on the order of 0.3° (ca. 33 km) or less. Of course, the records themselves do not explain whether these gaps represent true absences or simply lack of observations. I suspect the latter is a significant factor. There are no current records of *C. philhershkovitziana* between the towns Concón and Algarrobo, ca. 0.3° latitude. But the intervening distance comprises the cities of Viña del Mar and Valparaiso, whose coastal strands, save for a few narrow recreational beaches, are essentially completely paved over.

But there are two sorts of distributional gaps: those between shoreline localities and those between shoreline and more interior localities. Record 9 (Table 1) at ca. -30.3°S is a beach locality, whereas records 10–11, ca. -30.5°, are several km inland. Likewise, record 12 is from a beach locality at ca. -33.6°S, but records 13–17, spanning -30.7–31.4°S, are from localities further inland. Some of the inland localities are low elevation coastal flood plain, but others are at higher elevation and interior to a coastal range. The latter localities may be significantly drier than coastal localities.

Study of the actual geography of the coastal region at these latitudes reveals two patterns. The coast of the Coquimbo Region comprises mostly low hills and valleys 100–300 m in elevation. There are a few rivers that create coastal dunes, estuaries, and broad beaches, a favorite habitat of *C. philhershkovitziana*. But especially in the Limarí and Choapa Provinces, the interfluvial hills extend to waterfront cliffs. Here, beaches are relatively rocky and narrow, and *C. philhershkovitziana* seems to be absent. But the hilly landscape harbors other *Cistanthe* species, especially *C. chamissoi* (Barnéoud) Carolin ex Hershk., *C.*

coquimbensis (Barnéoud) Carolin ex Hershk., *C. thyrsoidea* (Reiche) Peralta & D.I. Ford, and *C. vicina* (Phil.) Carolin ex Hershk. The cliffs themselves are draped with *Cistanthe laxiflora* (Phil.) Peralta & D.I.Ford. There are few rivers in this zone. It is interesting, therefore, that the relatively few coastal records of *C. philhershkovitziana* in the Coquimbo region are limited to localities where runoff is greater, the coastal flood plain of Elquí Province and more fluvial localities further south.

At the same time, the more inland localities of the Coquimbo Region are disturbed roadsides, especially along the Panamerican Highway, much of which was cut directly through low hills. And the latter do not seem to be a habitat of *C. philhershkovitziana* in this area. Thus, the distribution of this species along the Panamerican Highway, in some places essentially continuous (Table 1, Fig. 1), seems to be *anthropogenic*. Given the weediness of many species of *Cistanthe* and Montiaceae in general (Hershkovitz, 2019), this should not be surprising.

But how can one explain the restriction of *C. philhershkovitziana* to coastal localities that are cool, humid, and have a relatively high water table and, in contrast, much hotter and drier interior roadcuts along the Panamerican highway? Simple. As I have noted (Hershkovitz, 2018a), *C. philhershkovitziana* is abundant only in years with significant rainfall, especially El Niño years. In more frequent dry years, it is virtually absent. But in the wet years, the Panamerican Highway itself becomes a sort of artificial fluvial system, concentrating the runoff from the adjacent hills. This reproduces the fluvial environment of the coastal localities.

I further recall here that well-developed plants of *C. philhershkovitziana* may produce several thousand seeds, and that the seeds themselves are covered with short and somewhat glandular hairs. This undoubtedly facilitated their dispersal inland, whether by native or introduced animals, vehicles, or humans themselves. Unfortunately, this renders difficult the reconstruction of the pre-human or even the ca. 1960s pre-Panamerican Highway distribution of this species (Fig. 3).

2. Morphological variability of C. philhershkovitziana

Different populations of *C. philhershkovitziana* vary mainly in a few floral traits, but this variation does not render ambiguous the taxonomic identity. The variation includes petal color, which may be more red or more purplish basally, stamen number, which is developmentally plastic, stigma color, reddish versus yellowish, and stigma height, which may be the same as or greater than stamen height. But the diagnostic morphological traits of the species are the peculiar carrot-like root, the all-basal leaf position, cylindrical rather than angled stems, and ground-ward reflection of the pedicels in fruit.

Individuals of *C. philhershkovitziana* also vary in leaf morphology. The leaves may be more or elliptical to more obovate and the apices rounded to acute. The leaf surface may be bullate (wrinkled and puffy) or smooth, and this is evident in photos in the URL links in Table 1. When smooth, the leaves seem to be more succulent, turgid, and rigid. It appears that individuals have one or the other leaf form, not both. It is not clear whether this variation is genetic or developmental or both.

Hershkovitz (1991b) reported that leaf venation of *Cistanthe* species is extremely sinuous. Moreover, the finer leaf veins are organized as flat "ribbons" rather than concentric bundles.[1] The ribbon vessel element pitting ranges from annular (i.e., protoxylem) distally to reticulate (i.e., metaxylem) proximal to the procambium. This indicates that the venation develops slowly in conjunction with the mesophyll, and this anatomy presumably affords vascular flexibility during development as young leaves expand and contract according to hydration. Thus, it is possible that the bullate condition reflects

[1] Among vascular plants, this leaf vein anatomy seems to be restricted to certain Montiaceae (Hershkovitz, 1991b).

development of metaxylem elements when the leaf is in a more hydrated state, whereas mesophyllar maturation may occur at a subsequent less hydrated ("wilted") state. Consequently, the veins would be buckled in the mature leaf, yielding the bullate condition. In contrast, leaf maturation in a continuous hydrated state would yield the smooth, turgid, rigid anatomy.

Acknowledgments

Elaboration of my 20 publications since 2018 and many more to follow would not have been possible except for the generous support and dedicated efforts of Fundación Reshet in Chile (www.reshet.cl). I unashamedly solicit and appreciate donations to this excellent humanitarian organization. For this work in particular, I gratefully acknowledge the philanthropy of legendary Chilean race horse owner/trainer Don José Tomás Allende for providing me with the only fieldwork funds I have received since 2002. I also thank Eric Rojas Abarca (https://www.inaturalist.org/people/dsprta) for sharing observations of *C. philhershkovitziana* populations growing between Valparaiso and San Antonio, Chile.

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Table 1. Distribution of *Cistanthe philhershkovitziana*. Documentation and comments. The localities are mapped in Fig. 1.

#	REGION-Province[2]	Locality	Latitude	km[3]	Elev[4]	Date	Observations	Reference
1	ATA-Hua	"Canyon n of Huasco"	¿ca. -28.5?	?	?	2010	I cannot confirm that the photo actually is from a "canyon north of Huasco;" hence neither the approximate latitude; plant with emerging inflorescences	https://www.forocactus.com/viewtopic.php?t=7842
2	ATA-Hua	?	?	?	?	IX 2022	The specimen appears in a short video among many in the "highlights" archive "Desierto Florido;" stigma yellowish	https://www.instagram.com/copuna_adventours/ https://www.instagram.com/stories/highlights/17982267952407611/
3	ATA-Hua	Highway C-500 between Domeyko and Caleta Chañaral 22 km w of Domeyko;	-28.975833	30	303	19 VIII 2022	Personal obs.; plants in rosette stage with very early development of inflorescences	Fig. 2
4	COQ-Elq	Choros, Camping Humboldt	-29.246328	-	-	20 IX 2022	Stigma yellowish	https://www.inaturalist.org/observations/135863601
5	COQ-Elq	La Serena; Quebrada de Peñuelas	-29.952227	1	?	22 VIII 2017	ID not certain; photo of a single flower with the base of the plant out of focus; overall morphology suggests this species and not *C. grandiflora*; stigma yellowish	https://www.inaturalist.org/observations/91348224
6	COQ-Elq	"Coquimbo"	ca. -30	1	?	23–30 VIII 1879	Herbarium collection: *W. Coppinger* s. n. (K: 001057601)	http://specimens.kew.org/herbarium/K001057601
7	COQ-Elq	Totoralillo; dunes	-30.061489	1.5	?	5 XI 2020	Single photo of one open flower and one reflexing fruiting flower; the short style indicates not *C. laxiflora*; the red petal base suggests not *C. grandiflora*; stigma magenta	https://www.inaturalist.org/observations/69019051
8	COQ-Elq	Panamerican Highway km 443 at Las Tacas exit; west side of road	ca. -30.09	2	?	20 IX 2000	Population observed multiple times in subsequent rainy but not dry years	[see https://www.phytologia.org/uploads/2/3/4/2/23422706/100_4_208-221herhershkovitzcistanthefig3_rev11-1-18.pdf]
9	COQ-Elq	Tongoy; mouth of Estero Tongoy	-30.259678	-	-	5 X 2016	Single photo of one flower; the petal color and evidently short plant height relative to background vegetation indicate this species; stigma magenta	https://www.inaturalist.org/observations/34576316
10	COQ-Lim	Panamerican Highway ca. 4 km n of Quebrada Seca exit	-30.480587	10	?	15 VIII 2020	Relatively clear photo of a population; flowers unusual, stamens ca. 10 or fewer, some anthers seem sterile, stigma magenta, nearly sessile	https://www.inaturalist.org/observations/56617584

[2] **REGIONS: ATA**, Atacama; **COQ**, Coquimbo; **VAL**, Valparaiso; **MET**, Metropolitana; **Provinces: Hua**, Huasco; **Elq**, Elqui; **Lim**, Limarí; **Cho**, Choapa; **Pet**, Petorca; **Val**, Valparaiso; **San**, San Antonio.
[3] Approximate distance ≥ 1km inland from the shoreline; distances less than 1 km are indicated with "-".
[4] Elevations very close to the shoreline are indicated with "-" and are presumed to be < 20 m.

Table 1, continued.

#	REGION-Province	Locality	Latitude	km	Elev	Date	Observations	Reference
11	COQ-Lim	Highway D-540 5–10km w of Panamerican Highway	ca. -30.5	10 – 20	ca. 100	IX 2010	Pers. obs.; large populations in sandy soil along road	
12	COQ-Lim	Fray Jorge National Park; beach area	-30.574008	-	-	9 IX 2021	Two records; one small plant in rosette stage, the other a small plant with single inflorescence and single open flower, stigma magenta	https://www.inaturalist.org/observations/94961597; https://www.inaturalist.org/observations/94961873
13	COQ-Lim	Fray Jorge National Park; coordinates indicate east slope of westernmost hill range	-30.651955	3	?	31 X 2021	Plant with 3 inflorescences; stamens ca. 50, stigma cream-colored	https://www.inaturalist.org/observations/99901244
14	COQ-Lim	Socos; jct. of Panamerican Highway and Highway 45 to Ovalle; field adjacent to tollbooth	ca. -30.7	20	?	2018	Photo by Lucia Abello; additional photos sent to me confirm the ID	https://www.flickr.com/photos/lucianativa/43184598830/in/album-72157696025378180/
15	COQ-Lim	Panamerican Highway between Peña Blanca and Alcones exits	-30.811596	3	?	10 VII 2021	Two small plants in rosette stage, no inflorescence	https://www.inaturalist.org/observations/86504598
16	COQ-Lim	Panamerican Highway between Maitencillo and Peña Blanca	ca. -30.9–31.2	5 – 25	?	X 2010	Distribution more or less continuous along highway shoulder	N/A
17	COQ-Cho	"Canela Baja"	ca. -31.4	15?	250 – 300?	?	The locality "Canela Baja" is vague, but the towis ca. 15 km inland; petals red at the base but with a well-defined white zone at the extreme base; stigma magenta.	https://www.researchgate.net/publication/349501656_Alain_de_Trenqualye's_photos_of_Cistanthe_philhershkovitziana_Hershk_Montiaceae
18	COQ-Cho	Huentelauquén	-31.60627	-	-	8 IX 2018	Small plant with one inflorescence/flower; stigma magenta	https://www.inaturalist.org/observations/96985320
19	COQ-Cho	Los Vilos; Panamerican Highway near junction with Highway D-85	ca. -31.9	1	?	X 1999	Single plant in sand on highway median	See https://www.phytologia.org/uploads/2/3/4/2/23422706/100_4_208-221herhershkovitzcistanthefig3_rev11-1-18.pdf
20	COQ-Cho	Quilimarí; mouth of Río Quilimarí	-32.114522	-	-	18 IX 2021	One small plant with single inflorescence; stigma magenta	https://www.inaturalist.org/observations/97475009
21	COQ-Cho	Pichidangi	-32.135286	-	-	28 IX 2021	Large plant, many inflorescence stems; stigma magenta	https://www.inaturalist.org/observations/96829875
22	VAL-Pet	Pichicuy, Humedal de Pichicuy, mouth of Río Huaquén	-32.347	-	-	11 X 2018	Stigma yellowish; I observed this population several times in the years 2003–2010 .	https://www.phytologia.org/uploads/2/3/4/2/23422706/100_4_208-221herhershkovitzcistanthefig3_rev11-1-18.pdf
23	VAL-Pet	Zapallar; beach	ca. -32.5	-	-	2005		[Photo in Villagrán, C., Marticorena, C. & Armesto, J. J. 2007. Flora de las plantas vasculares de Zapallar. Puntángeles y Fondo Editorial U.M.C.E., Santiago, Chile.]

Table 1, continued.

#	REGION-Province	Locality	Latitude	km	Elev	Date	Observations	Reference
24	VAL-Qui	"Quillota"	ca. -32.5	25	-	VIII–X 1829	Herbarium specimen: *Bertero 1349* (NY: 02065851)	http://sweetgum.nybg.org/science/vh/specimen_details.php?irn=2247886
25	VAL-Val	"Quintero"	ca. -32.8	-	-	IX 1923	Herbarium specimen: *Werdermann 39* (E: 00033182)	http://data.rbge.org.uk/herb/E00033182
26	VAL-Val	Concón, beach at mouth of the Río Aconcagua (coordinates indicate this locality but reference indicates Quintero, ca. 15 km to the north)	-32.911958	-	-	26 IX 2021	One small plant with single inflorescence; flowers not open	https://www.inaturalist.org/observations/96229664
27	VAL-Val	Concón; Dunas de Concón	-32.952087	-	-	5 IX 2020	The plant seems to be growing in a dense vegetation of exotic grasses. The petals seem very pale mauve apically, but this might be an exposure artifact. Basally the petals are red. Stigma magenta.	https://www.inaturalist.org/observations/58621350
28	MET-Cha	Chacabuco Province; Highway F-10-G; scrub vegetation near Puente Santa Laura	ca. 33.1	60	?	X 1999	Field observation	[see https://www.phytologia.org/uploads/2/3/4/2/23422706/100_4_208-221herhershkovitzcistanthefig3_rev11-1-18.pdf]
29	VAL-Val	Algarrobo; sands s of Mirasol (evidently Playa Algarrobo Norte)	ca. 33.3	-	-	15 X 1951	Herbarium specimen: *Kausel 3227* (H, C.269474)	https://www.gbif.org/occurrence/3439893820
30	VAL-Val	Northern limit of El Quisco; the coordinates suggest Playa Canela Canelillo	-33.372005	-	-	16 X 2020	The petals are mauve apically, more or less violet-red basally. Stigma magenta.	https://www.inaturalist.org/observations/64707879
31	VAL-Val	Southern limit of El Quisco, evidently Playa Punta de Tralca	-33.399108	-	-	28 V 2022	Very early rosette stage.	https://www.inaturalist.org/observations/119102624
32	VAL-Val	Southern limit of El Quisco, evidently Playa Punta de Tralca	-33.422383	-	-	29 IX 2021	Petals mauve apically, seem to be violet-red basally; stigma lobes pale violet, otherwise the stigma is pale.	https://inaturalist.mma.gob.cl/observations/96634941
33	VAL-Val	El Tabo; Paseo del Sol	-33.448912	-	-	12 VI 2022	Early rosette stage	https://www.inaturalist.org/observations/121502159
34	VAL-Val	El Tabo; in sand evidently on platted terrain in a beachfront neighborhood.	-33.464987	-	-	24 XI 2021	Senescent plant	https://www.inaturalist.org/observations/101839949
35	VAL-Val	El Tabo; evidently near Playa de la Chepica	-33.47158	-	-	20 VIII 2022	Rosette stage with a single inflorescence bud evident in an axil. The taproot at this stage is ca. 8 mm broad.	https://www.inaturalist.org/observations/131652712
36	VAL-Val	El Tabo; evidently near Playa de la Chepica	-33.470383	-	-	24 XI 2021	Senescent plant	https://www.inaturalist.org/observations/101839827
37	VAL-Val	El Tabo; dunes e of La Puntilla	-33.480012	1	-	23 VI 2022	Rosette stage	https://www.inaturalist.org/observations/123164272

Table 1, continued.

#	REGION-Province	Locality	Latitude	km	Elev	Date	Observations	Reference
38	VAL-Val	Southern end of El Tabo near La s Cruces	-33.487217	-	-	21 VI 2022	Rosette stage	https://inaturalist.mma.gob.cl/observations/122867122
39	VAL-Val	Cartagena; Sandy flat along Estuario de Cartegena	-33.532208	-	-	24 XI 2020	Very large plant; root appears to be ca. 4 cm thick; stigma magenta	https://inaturalist.mma.gob.cl/observations/68742666
40	VAL-Val	Cartagena; Sandy flat along Estuario de Cartegena	-33.532845	-	-	17 X 2019	Very large plant; 12 inflorescence stems, > 50 flowers/fruits; stigma magenta	https://www.inaturalist.org/observations/42613439
41	VAL-Val	Santo Domingo; Reserva Nacional El Yali	-33.74489	-	-	10 IX 2021	Small, evidently stunted plants; stigma magenta	https://www.inaturalist.org/observations/94387767
42	VAL-San	Santo Domingo; Reserva Nacional El Yali (reference indicates “San Antonio”)	-33.752289	-	-	15 IX 2021	Small, evidently stunted plants; stigma magenta	https://www.inaturalist.org/observations/100016168
43	VAL-San	Santo Domingo; Reserva Nacional El Yali (reference indicates “San Antonio”)	-33.753667	-	-	26 IX 2020	Flowers appear to be about half the diameter of those further north; stigma magenta	https://www.inaturalist.org/observations/66773715
44	VAL-San	Santo Domingo; Reserva Nacional El Yali (reference indicates “San Antonio”)	-33.753667	-	-	26 IX 2020	Flowers appear to be about half the diameter of those further north; stigma magenta	https://www.inaturalist.org/observations/66773715

Fig. 1. Distribution map of *Cistanthe philhershkovitziana*. The documented localities are denoted with an asterisk, and the associated numbers correspond to those in Table 1. Localities 1, 2, and 6 are ambiguous and therefore not mapped. **A.** Northern portion of the distribution. **B.** Southern portion of the distribution.

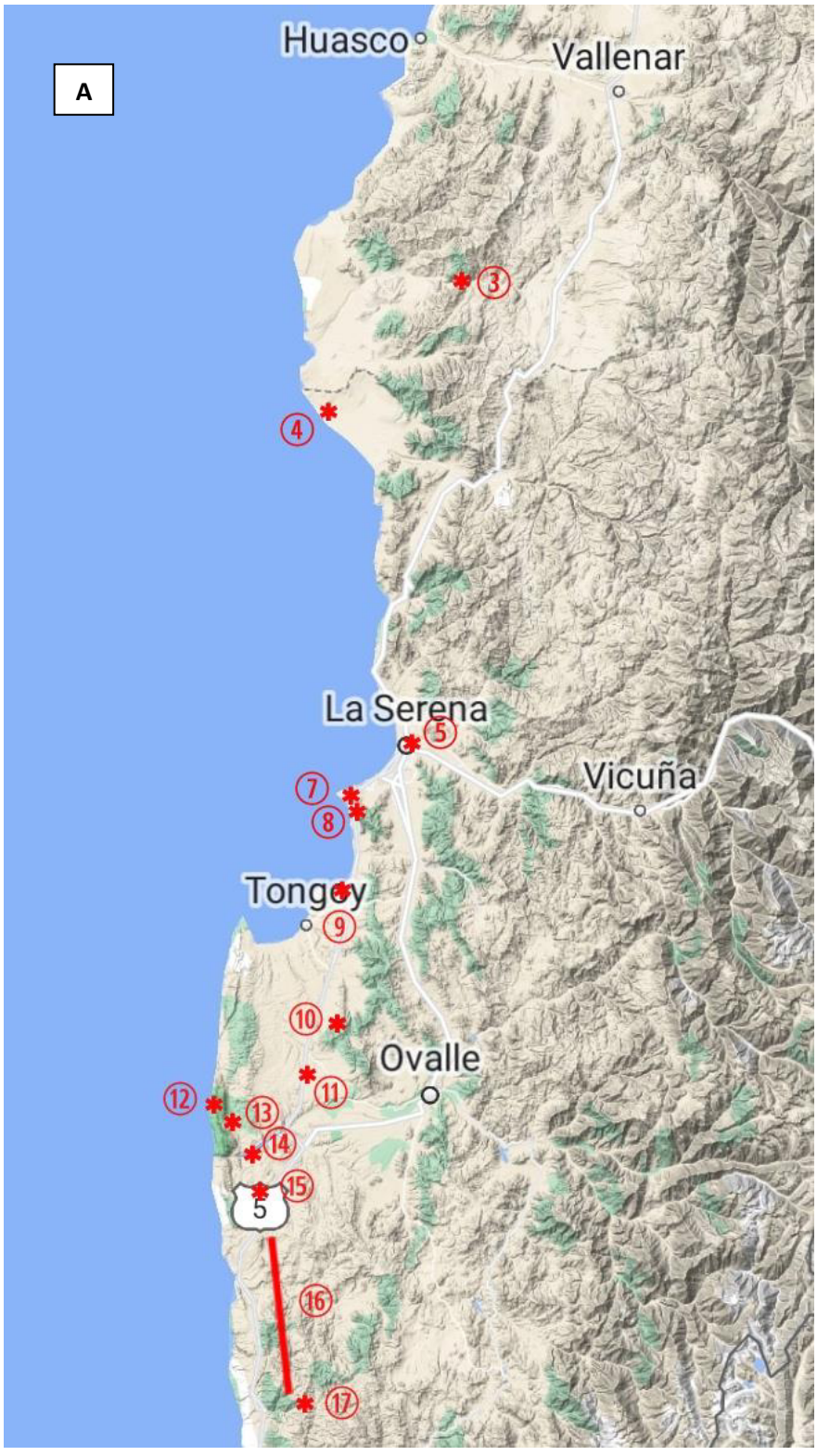

Fig. 1, continued.

Fig. 2. Rosette-stage plants of *C. philhershkovitziana* collected along Highway C-500 22.5 km west of Domeyko (Atacama Region, Huasco Province), Chile (record 3 in Table 1).

Fig. 3. 1947 map of Coquimbo Province. Note that the Panamerican Highway is absent. The westernmost road from Los Vilos to Ovalle (ca. 50 km inland) followed a course some 30 km inland and was unpaved (and a portion remains unpaved today). Coastal access was mainly by trails scarcely and sometimes not suitable for motor vehicles. At that time, *C. philhershkovitziana* was documented in the Coquimbo Region only from Coquimbo city and otherwise from localities in the Valparaiso Region well south of Los Vilos (Hershkovitz, 2018b). Obviously it would have been absent along the Panamerican Highway roadcut, where it is common today. Map downloaded from https://www.geovirtual2.cl/region-de-coquimbo-chile/historia-coquimbo/mapa-1947-veraneante-600espanol.htm.