

GEA, FLORA ET FAUNA

The genera *Cereus* and *Trichocereus* (Cactaceae: Cactoideae) as alien plants in Catalonia (northeastern Iberian Peninsula): amendments and new chorological data

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Abstract

New data on the identity and distribution of alien plants of the genera *Cereus* and *Trichocereus* in Catalonia are presented. *Cereus jamacaru*, *C. repandus* and *C. peruvianus* should be excluded from the flora of Catalonia. At present, the only species of *Cereus* regarded as casual in the studied area is *C. hildmannianus*. Four species of *Trichocereus* (*T. macrogonus*, *T. schickendantzii* subsp. *schickendantzii*, *T. spachianus* and *T. taquimbalensis*) are currently known the studied area.

Keywords: cactus, alien flora, Mediterranean region.

Resum

Els gèneres *Cereus* i *Trichocereus* (Cactaceae: Cactoideae) a Catalunya (nord est de la península Ibèrica): esmenes i noves dades corològiques

S'aporten noves dades sobre la distribució i la identitat de plantes al·lòctones a Catalunya dels gèneres *Cereus* i *Trichocereus*. *Cereus jamacaru*, *C. repandus* i *C. peruvianus* han de ser exclosos de la flora de Catalunya. Per ara, l'única espècie del gènere *Cereus* que es pot considerar com a escapada de cultiu al territori considerat és *C. hildmannianus*. Quatre espècies de *Trichocereus* (*T. macrogonus*, *T. schickendantzii* subsp. *schickendantzii*, *T. spachianus* i *T. taquimbalensis*) són actualment conegudes de l'àrea estudiada.

Paraules clau: cactus, flora al·lòctona, Regió mediterrània.

Introduction

A large number of species belonging to the cactus family (Cactaceae) of American origin are cultivated as ornamental plants in the gardens of the Mediterranean region. Although there are relatively few cactus species that become naturalized in natural or semi-natural habitats, many of them can persist for years in the form of isolated individuals. In some cases small populations are maintained exclusively by vegetative propagation.

In recent times, a considerable effort has been devoted to improving knowledge on escaped crop cacti in the western Mediterranean region (e.g. Guillot *et al.*, 2009; Guiggi, 2010; Aymerich, 2015). This knowledge involves considerable difficulties, derived from several factors: i) observations often refer to undeveloped and non-reproductive plants, ii) the existence of clones used in gardening that only represent a small (and sometimes atypical) part of the characters of a species,

iii) the heterogeneity and instability of the taxonomic treatments, along with the scarce, partial or poorly updated literature. Due to these factors misidentifications of the plants that are escaped in the Mediterranean region are not exceptional, so it is advisable to review and correct, if necessary, the published data.

An example of these misidentifications recently detected affects some records of the columnar cacti of the genus *Cereus* Mill. in Catalonia. We have observed that most of the published data on *Cereus* are due to confusion with species of the genus *Trichocereus* (Berger) Riccob., which also have a columnar growth and can reach a large size (up to 2.5 m high in some locations). The aim of this work is to update and synthesize the available information on the plants of the genera *Cereus* and *Trichocereus* observed as escaped in Catalonia, correcting misidentifications published in previous studies and providing new chorological data.

Regarding the degree of naturalization (Richardson *et al.*, 2000), all of these introduced species should be regarded as

casual, although in some cases a trend towards local naturalization or, at least, a medium-term persistence by means of clonal growth is observed. With regard to their origin, it is assumed that dumping of yard trimmings and green waste could explain the local establishment of these species outside the garden areas, although in some cases a deliberate planting in natural or semi-natural habitats can not be ruled out. The concentration of several columnar cacti species in Blanes (see below) is likely to be related to the relative proximity of the garden «Pinya de Rosa», which has an important collection of cacti, although the area where the escaped cacti are found is currently disconnected from the activity of this garden.

In this work the genus *Trichocereus* is considered separately from *Echinopsis* Zucc., within which very often it has been included. In fact, all previous reports of *Trichocereus* species in Catalonia have been made as *Echinopsis*. Both genera are separated based on the following evidences: i) *Echinopsis* is polyphyletic (Schlumpberger & Renner, 2012), ii) *Trichocereus* is monophyletic (Albesiano & Terrazas, 2012) and iii) the *Trichocereus* clade is supported by three synapomorphies: basitonic growth with prostrate branches, imbricate scales along the floral tube, and subglobose fruits (Albesiano & Terrazas, 2012). Without considering the species that were included within *Trichocereus*, two species of *Echinopsis* were reported from Catalonia: *E. eyriesii* (Turpin) Pfeiff. & Otto (Aymerich, 2015) and *E. oxygona* (Link) Zucc. (Gómez-Bellver *et al.*, 2019a).

Material and methods

We performed a floristic survey and bibliographic revision of the studied genera from 2014 to 2019. The taxonomic literature used for identification is mentioned along with the data provided for each species. The International Plant Names Index (IPNI, 2019) database was used to verify the current accepted name for each species surveyed. All field pictures were taken by the authors. For each species, the observations that are considered valid (based on revised bibliographic data and unpublished information) are exposed and the misidentifications are discussed. The records provided for each accepted species are only documented with pictures, since these cacti are difficult to collect and preserve as dried specimens. Accepted names are shown in bold face and italics font. Taxa excluded from the studied area are written in italics and plain format. For each accepted species information on its distribution in the studied area, geographic origin, overall distribution, invasiveness is also provided. Demographic data on the populations (colonies) of species are provided when known.

Results and discussion

Five non-native species of *Cereus* and *Trichocereus*, which were introduced as ornamental plants, exist (as casual) in the studied area. Among the new records presented

here, there are some new for Europe as a whole, including *T. schickendantzii* (F.A.C. Weber) Britton & Rose subsp. *schickendantzii* and *Trichocereus taquimbalensis* Cárdenas. The new interpretations and discoveries provided in this study are discussed below. The species are arranged in alphabetical order.

Cereus

According to current available data, only one species of this genus present in Catalonia as an escaped plant is *C. hildmannianus*, whereas reports of *C. jamacaru* and *C. repandus* [= *C. peruvianus*] are erroneous.

C. hildmannianus K. Schum.

Baix Camp: Mont-roig del Camp, Riera de Riudecanyes, grassy places on the riverbed, 31TCF3149, 60 m a.s.l., a single small individual, 4 Nov 2017, P. Aymerich & L. Gustamante (Fig. 1 c,d); Mont-roig del Camp, Riera de Riudecanyes, grassy places on the riverbed, 31TCF3150, 55 m a.s.l., a single small individual, 4 Nov 2017, P. Aymerich & L. Gustamante; Cambrils, left bank of Riera d'Alforja, 31TCF3452, 90 m, slope between a field and the riverbed, three medium-sized individuals, 2 Apr 2019, P. Aymerich; Cambrils, Riera d'Alforja, 31TCF345, 100 m a.s.l., slopes, five medium-sized individuals, 12 Aug 2003 (Sanz *et al.*, 2004; sub *Cereus peruvianus* (L.) Mill.). Selva: Blanes, coastal area of Sa Llapissada, 31TDG8414, 40-80 m a.s.l., rocky slope on the sea covered with a clear *Pinus halepensis* forest, growing together with several cactaceae (*Opuntia ficus-indica*, *O. tomentosa*, *O. lindheimeri*,...), ten individuals different in size (between 0.5 m and 8 m high), 12 Apr 2019 P. Aymerich (Fig. 1 a, b). Part of the plants from this location were erroneously referred to *Cereus jamacaru* DC. by Aymerich (2017) should be referred to *C. hildmannianus*. Selva: Brunyola, sota Cal Xacó, 31TDG7138, 260 m a.s.l., roadside, a single individual growing within a dense population of *Opuntia monacantha*, 30 May 2019, P. Aymerich.

This species is native to South America: Argentina, Brazil, Paraguay and Uruguay (Braun *et al.*, 2017). In Europe *C. hildmannianus* is also known as locally naturalized in Liguria, northeastern Italy (see Guiggi, 2010). Probably also correspond to this species reports of *C. peruvianus* and *C. repandus* from Valencia (Guillot *et al.*, 2009; Guillot, 2013).

The plants of from the above-mentioned localities are referable to *C. hildmannianus* due to the presence of dark young spines, generally blackish or reddish (Zappi *et al.* 2007; Walters *et al.*, 2011). The available information on the record from Riera d'Alforja (Sanz *et al.*, 2004) is insufficient, but we have assumed that it also corresponds to *C. hildmannianus* due to its proximity to the recent observations of this taxon. Since most of the individuals that have been found are juveniles, it has not been possible to observe flowers, whose characters would allow a more consistent identification. The lack of flowers does not allow to attribute these plants to any of the two subspecies described, although considering the usual presence of spines, always more or less abundant, it seems that they can refer to the subsp. *uruguayanus* (R.

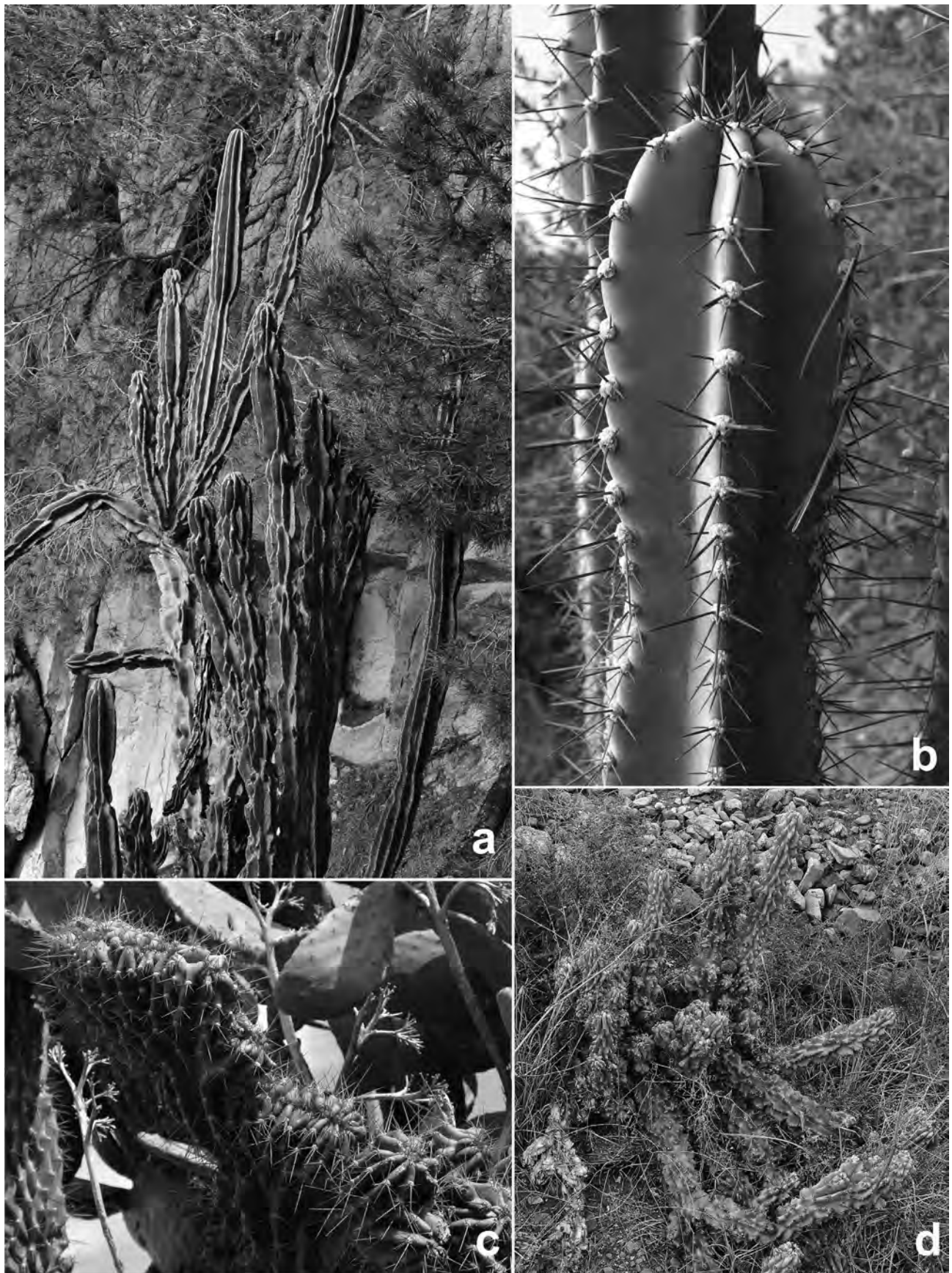


Figure 1. *Cereus hildmannianus* from Blanes: a) large, arborescent individual; b) stem and spines. *Cereus hildmannianus* forma *monstruosa* (with stems of anomalous growth) from riera de Riudecanyes: c, d.

Kiesling) N.P. Taylor. Typical *C. hildmannianus* has larger flowers and generally does not have spines (Anderson, 2001). It should also be noted that the distinction between these two subspecies is not accepted by some authors (Anceschi & Magli, 2010). The individuals observed in southern Catalonia (Baix Camp) correspond to f. *monstruosa*, with stems of anomalous growth, which is often used in gardening. However, in Blanes plants present stems with a normal growth.

Excluded species

C. jamacaru DC.

This species was erroneously reported from Blanes (Aymerich, 2017), where the existing individuals of *Cereus* correspond to *C. hildmannianus*. The error was due to the fact that for the identification we also used photos of *Trichocereus macrogonus*, which exists in the same locality (in which there are four species of columnar cacti) and the individuals of which were interpreted as *Cereus* juveniles. Since both *T. macrogonus* and *C. jamacaru* have young yellowish spines, it was erroneously assumed that all plants corresponded to the latter species.

C. jamacaru is a native species from eastern Brasil, that along with *C. hildmannianus* and other related species forms a group of phylogenetically related taxa (Faria *et al.*, 2017) and that are difficult to separate by means of morphological characters.

C. repandus (L.) Mill.

This species was reported from de Sitges (Sáez & Guillot, 2015) and Sant Feliu de Codines (Gómez-Bellver *et al.*, 2016) due to confusion with *Trichocereus macrogonus* and *T. spachianus*, respectively (see below). *C. repandus* is native to north South America and it is closely related to *C. hildmannianus* and *C. jamacaru*. In the studied area it is very rarely cultivated.

C. peruvianus (L.) Mill.

This name was widely used for *Cereus* in gardening. At present, it is accepted that it is a synonym of *C. repandus* (Hunt, 2016). Sanz *et al.* (2004) reported *C. peruvianus* from Riera d'Alforja where the existing individuals of *Cereus* correspond, according to our observations, to *C. hildmannianus*.

Trichocereus

According to the taxonomic treatment of Albesiano (2015), four species of *Trichocereus* have been observed in Catalonia as casuals: *T. macrogonus*, *T. spachianus*, *T. schickendantzii* and *T. taquimbalensis*.

T. macrogonus (Salm-Dyck) Riccob.

Baix Camp: Cambrils, left bank of Riera d'Alforja, 31TCF3550, 50 m a.s.l., on the edge of a path, in an area with abundant presence of other cacti (*Opuntia ficus-indica*, *O. phaeacantha*, *Austrocylindropuntia subulata*), a juvenile individual, 2 Apr 2019, P. Aymerich. Baix Penedès: Masllorç,

Masarbonès, 31TCF6968, 275 m a.s.l. east periphery of the village, an adult individual next to a house in ruins, growing together with *Opuntia ficus-indica*, 26 March 2015 P. Aymerich. Garraf: Sitges, entre la punta dels Coralls i cala Ginesta, 2-4 m, maritime rocks, two medium-sized individuals, 15 March 2014, I. Granzow & L. Sáez in Sáez & Guillot (2015); erroneously reported as *Cereus repandus* (L.) Mill. Selva: Blanes, coastal area of Sa Llapissada, 31TDG8414, 20-70 m a.s.l., rocky slope on the sea covered with a clear *Pinus halepensis* forest, growing together with several cactaceae (*Opuntia ficus-indica*, *O. tomentosa*, *O. lindheimeri*,...), fifteen individuals in different sizes (between 0.5 m to 2.5 m high), 12 Apr 2019 P. Aymerich (Fig. 2a-e); part of the plants identified as *Cereus jamacaru* DC. by Aymerich (2017) should be referred to *T. macrogonus*.

According to Albesiano & Kiesling (2012) the species is naturally distributed in high valleys of Peru and perhaps northwestern Bolivia, but it is cultivated (see below) over a wider area, including Ecuador and northern Chile. In Europe, *T. macrogonus* was previously reported only from eastern Spain, in the Valencia province (Laguna *et al.*, 2013, sub *Echinopsis pachanoi* (Britton & Rose) H. Friedrich & G.D. Rowley).

The species concept of Albesiano & Kiesling (2012) is followed here. The mentioned authors include within *T. macrogonus* plants called *Trichocereus pachanoi* Britton & Rose [*Echinopsis pachanoi* (Britton & Rose) H. Friedrich & G.D. Rowley] and *T. peruvianus* Britton & Rose [*E. peruviana* (Britton & Rose) H. Friedrich & G.D. Rowley], which are recognized as distinct at varietal level only: var. *pachanoi* (Britton & Rose) S. Albesiano & R. Kiesling and var. *macrogonus*, respectively. The taxonomic adscription of the plants observed in the studied area to any of the varieties recognized by Albesiano & Kiesling (2012) is unclear. Only the individual found in Cambrils, without spines, seems clearly referable to var. *pachanoi*. Plants from Blanes do not fit well in either of the two varieties due to the number of spines (9-13) of the older areoles. However, these individuals seem referable to var. *macrogonus* based on the thickness and length of these spines, although there is also some plant without spines, more similar to var. *pachanoi*. On the other hand, the plants observed in Baix Penedès and Garraf are closer to the var. *macrogonus* if the spines characters are taken into account.

In addition to the locations previously reported, *T. macrogonus* likely exists in Roquetes (Baix Ebre, 31TBF8718), since plants that apparently correspond to this species are observed (Gómez-Bellver *et al.* (2019b, Figures 2D and 2E), growing together with *T. spachianus* and *Agave americana*. We have not included this information between the confirmed locations because it can not be excluded that it is *T. bridgesii* (Salm-Dyck) Britton & Rose from these photographs. The latter species is morphologically very close to *T. macrogonus*, from which it is distinguished only by few spine characters or through genetic information (Albesiano, 2015). These distinctive morphological characters of *T. bridgesii* are not present in the Catalan plants that we have attributed to *T.*

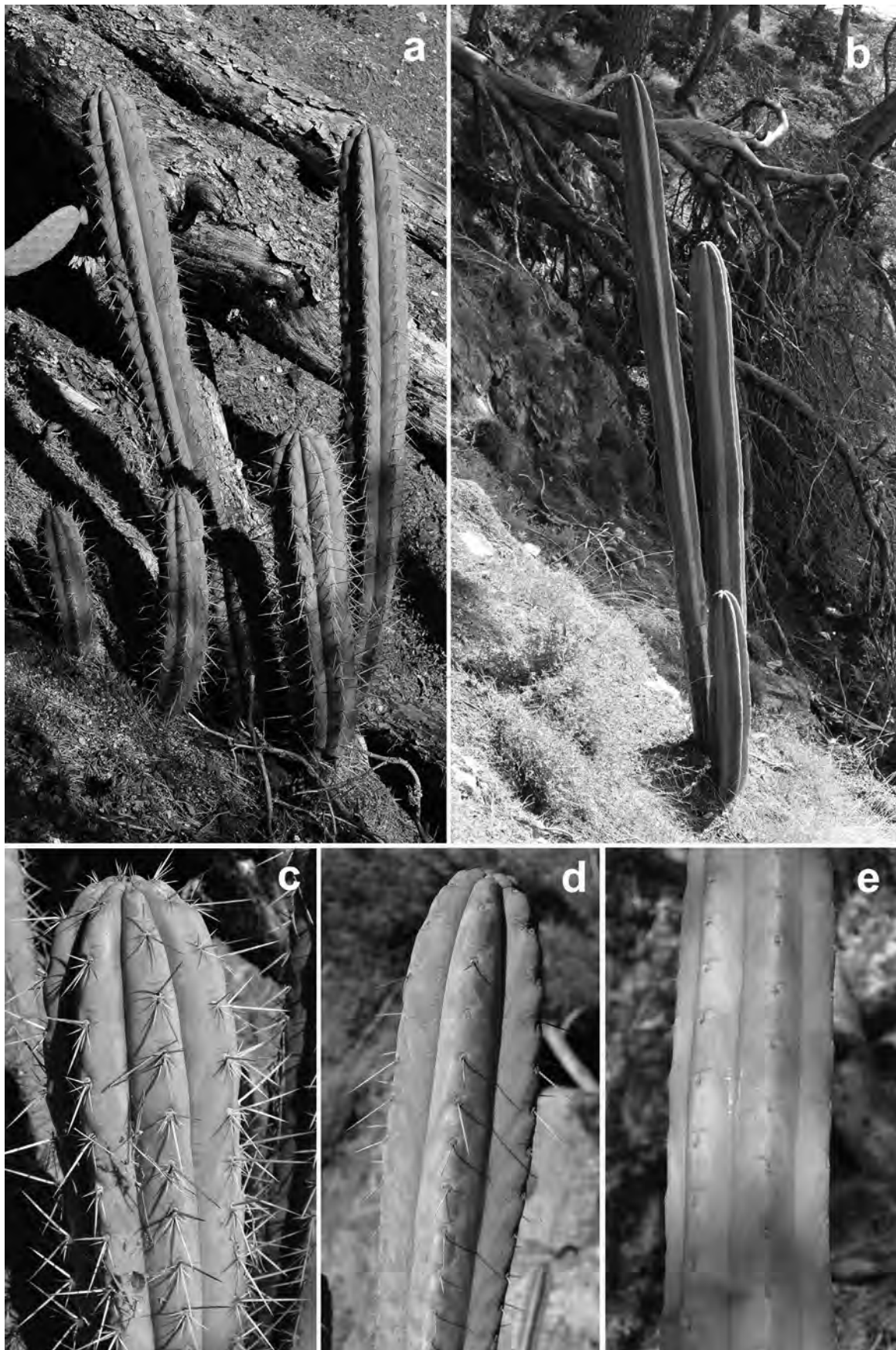


Figure 2. *Trichocereus macrogonus* from Blanes: a, c) stems prickly individual; b) large, arborescent spineless individual; d) stem of an almost spineless individual; e) stem of a spineless individual.

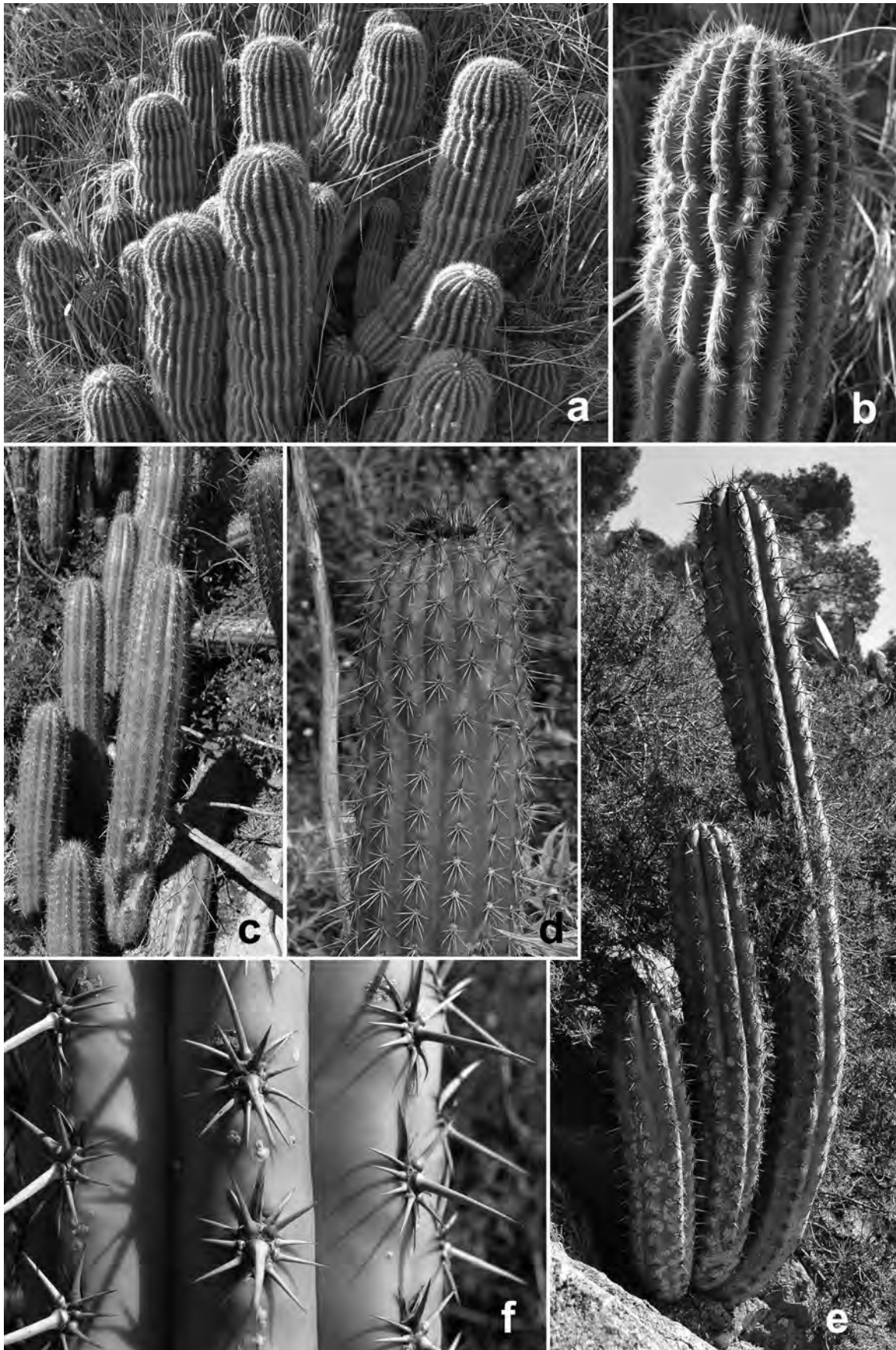


Figure 3. *Trichocereus schickendantzii* from Calaf: a, b). *Trichocereus spachianus* from Blanes: c) and Caldes de Monbui d). *Trichocereus taquimbalensis* from Blanes: e, f).

macrogonus. In Europe, *T. bridgesii* is only known from a locality in southeastern Iberian Peninsula, Alicante province (Verloove *et al.*, 2018).

All the varieties recognized within *T. macrogonus* and *T. bridgesii* (called under the local Spanish common name of “cactus San Pedro”) are very widely known for its hallucinogenic properties (Albesiano & Kiesling 2012; Mandujano & Mandujano, 2014). These plants contain alkaloids (particularly mescaline, the predominant psychoactive alkaloid), and have traditionally been used in rituals of the aboriginal peoples of the Andes and as drugs in modern times (Mandujano & Mandujano, 2014). Currently there is an active trade of these cacti (and of supposed hybrids between species and varieties) basically for use as a drug.

T. schickendantzii (F.A.C. Weber) Britton & Rose subsp. *schickendantzii*

Anoia: Calaf, el Clotet, serra de Sant Sebastià, 31TCG7519, 670 m a.s.l., herbaceous margin with remains of dry stone walls, clonal group with c. 60 columnar stems, 23 March 2019, P. Aymerich (Fig. 3a,b). Solsonès: Castellar de la Ribera, castell de Castellar, 31TCG6853, 645 m a.s.l., slopes with ruderal vegetation, two clonal groups of 50 and 8 columnar stems, 10 and 14 May 2015 (Aymerich, 2015, sub *Echinopsis schickendantzii* F.A.C. Weber).

According to Albesiano (2015), this subspecies is native to northwestern Argentina. As far as we know it has not been reported in anywhere in Europe. According to the identification key of the subspecies recognized within *T. schickendantzii* (Albesiano, 2015) the observed plants are referable to typical *T. schickendantzii* based on the number, length and colour of the spines and by the size of the stems.

This cactus is often planted as ornamental in the rural gardens of central Catalonia, as it resists the cold winter temperatures. We have observed that it persists with good vitality in the former gardens of abandoned houses, in the municipalities of Solsona and Lladurs (Solsonès), at 700-720 m a.s.l..

T. spachianus (Lem.) Riccob.

Anoia: Òdena, north periphery of the urban area, 31TCG8607, 410 m a.s.l., slope with ruderal vegetation, clonal group with more than 100 columnar stems, 2 June 2015 (Aymerich, 2015, sub *Echinopsis spachiana* (Lem.) Friedrich & G.D. Rowley). Baix Ebre: Roquetes, Mas d'en Sedó, 31TBF8718, 45 m a.s.l., road slope, 6-7 adult individuals and 2 juveniles, 18 July 2016 (C. Gómez-Bellver, J. López & N. Nualart in Gómez-Bellver *et al.*, 2019b). Selva: Blanes, coastal area of Sa Llapissada, 31TDG8414, 30-50 m a.s.l., rocky slope on the sea covered with a clear *Pinus halepensis* forest, 10 individuals, 26 March 2017 and 12 Apr 2019, P. Aymerich (Fig. 3c) (Aymerich, 2017, sub *Echinopsis spachiana* (Lem.) Friedrich & G.D. Rowley). Vallès Oriental: Sant Feliu de Codines, el Gurugú, 31TDG3015, 470 m a.s.l., rocky siliceous slopes, a clone with 10 columnar stems, 10 Apr 2016 L. Sáez in Gómez-Bellver *et al.* (2016, sub *Cereus repandus* (L.) Mill.); Caldes de Montbui, Plans de can Pujol, 31TDF0706, 170 m a.s.l., wayside with ruderal vegetation, a juvenile indi-

vidual (1 m high) escaped from cultivation near an old building where a clonal group of several tens of columnar stems exist, 29 Apr 2019, L. Sáez (Fig. 3d).

This species is native to northwestern Argentina and southern Bolivia (Albesiano, 2015). *T. spachianus* is the most widely cited species of the genus in Europe: northern and southern Italian Peninsula and Sicily (Guiggi, 2014), Valencia (Gómez *et al.*, 2013) and Catalonia.

Trichocereus taquimbalensis Cárdenas

Selva: Blanes, coastal area of Sa Llapissada, 31TDG8414, 50-70 m a.s.l., rocky slope on the sea covered with a clear *Pinus halepensis* forest, growing together with several cactaceae (*Opuntia ficus-indica*, *O. tomentosa*, *O. lindheimeri*,...), two medium-sized individuals, 12 Apr 2019, P. Aymerich (Fig. 3e,f).

This species is native to Bolivia (Albesiano, 2015). As far as we know, this is the first report for Europe. We do not know any European reference for a closely related species: *T. tacaquirensis* (Vaupel) Cárdenas. *T. taquimbalensis* has been sometimes included within the synonymy of *T. tacaquirensis* (Hunt *et al.* 2006) or recongized at subspecies level [*Echinopsis tacaquirensis* subsp. *taquimbalensis* (Cárdenas) G. Navarro] although Albesiano (2015) considers that there are enough morphologic characters to split both taxa at species level.

According to the information provided by Albesiano (2015) we attribute to *Trichocereus taquimbalensis* two individuals observed in Blanes, where they grow together with *T. macrogonus* and *T. spachianus*. The characters on which our identification is based are: the absence of a dermal furrow on the areoles, the low number of ribs (less than 10) and radial spines (9-11) in the apical areoles, the solitary and subulate central spine of these areolas; and that all the spines are thick and robust, more than in any of the cactus species considered in this study.

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