Typification of the Iberian endemic Juniper Juniperus navicularis Gand. (Cupressaceae)

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Abstract

The typification of the name Juniperus navicularis (Cupressaceae) is provided, based on a thorough literature review and examination of original herbarium material deposited in the Gandoger collection (LY). In addition to discussing the historical background of the name and various assignments by different authors, we further studied additional types from Portuguese collections (LISU, COI, and PO) and other historical herbaria (H and P), cited in the species protologue.

Key words: Lectotype, nomenclature, Juniperus oxycedrus, taxonomy, type, Gandoger

Introduction

Juniperus Linnaeus (1753: 1038) (Cupressaceae) is a phanerophytic genus with a continuous distribution across the northern hemisphere, where it is an important component in semi-arid and mountain ecosystems. Within the genus, three sections were recognized by Adams (2004): 1- Sect. Caryocedrus Endlicher (1847: 2); 2- Sect. Juniperus, and 3—Sect. Sabina (Miller 1754: 412) Spach (1841: 291). This division has been later supported by molecular studies (Adams 2008, Mao et al. 2010). Yang et al. (2022), in a recent gymnosperm classification, treated the sections as three different genera, i.e., Arceuthos Antoine & Kotschy (1854: 249), Sabina Miller (1754: 412) and Juniperus, respectively. Juniperus s. str. comprises about 13 dioecious species (Adams 2014) that occur from the Mediterranean and Macaronesian regions to East Asia with one circumboreal species, i.e., J. communis Linnaeus (1753: 1040), distributed also in North America (Caudullo et al. 2017). Characteristic features of this group are the linear-acicular leaves in whorls of three with whitish stomatal bands on the upper side and articulated at the base, and mature cones varying in size, ranging from 8 to 18 mm, and bluish or reddish in color, usually including three seeds. Within this group, there is a Mediterranean-Macaronesian species aggregate that includes J. oxycedrus Linnaeus (1753: 1038) and six allied species characterized by leaves with two stomatal bands and red-orange mature seed cones (Adams 2014): J. badia (Gay 1889: 501) Rivas-Martinez, Molero Mesa, Marfil & G.Benítez (2020: 119), J. brevifolia Antoine (1857: 16), J. cedrus Webb & Berthelot (1847: 277), J. deltoides Adams (2004: 47), J. macrocarpa Smith (1816: 263), J. navicularis Gandoger (1910: 55), and J. maderensis (Menezes 1908: 227-228) Adams (2010b: 53) (Adams et al. 2010a-b, Adams & Schwarzbach 2012, Diez-Garretas et al. 2017). Among these, the sea sands juniper (J. navicularis) was
initially described by Gandoger (1910) as a putative new species, based on samples collected from different localities in Portugal. These included Extremadura (surroundings of the village of Coina), and Alentejo Litoral (surroundings of the villages of Tróia, Alcácer do Sal and Grândola). The species was included in the variability of J. oxycedrus var. brachyphylla Loret (1865: 282) in Billot (1865) by Coutinho (1909) or J. macrocarpa by Sampaio (1910).

The range of J. navicularis comprises Portugal and Spain, mostly across the acidic and sandy coastal areas of the Coastal Lusitanian and West Andalusian biogeographical province (Rivas-Martínez et al. 2017). The species grows both in the understory of psamophiliic cork oak forests and Montado (Aro neglecti-Quercetum suberis) and inland dunes (palaeodunes of Plio-Quaternary origin). It can thrive also in podzolized soils with a clay bedrock, often with a deep water table, where microphanerophilic communities develop (Rivas-Martínez 1990, Neto 2002, Neto et al. 2007, Rivas-Martínez et al. 2011, Costa et al. 2012, Garcia et al. 2014). The sea sands Juniper is a Near Threatened species following IUCN criteria (NT), and has the same status at the Portuguese national level, being severely threatened by land use change and ageing of its populations (Farjon 2013, Castro et al. 2016, Carapeto et al. 2020).

Different studies have been conducted about the putative phylogenetic relationships of J. navicularis and the rest of the taxa within Juniperus sect. Juniperus. Historically, there has been ambiguity regarding its placement, usually associating it alternatively either with the J. oxycedrus group or with the Azorean species J. brevifolia (Adams 2014). A preliminary approach to these relationships was proposed by Adams et al. (1998, 2000), by analyzing essential oils, concluded that J. brevifolia had a divergent evolutionary pathway, while J. navicularis resulted more closely related to J. oxycedrus and J. communis. Nevertheless, a phylogenetic tree based on the Internal Transcribed Spacer (ITS) region of nrDNA and one plastid DNA region pointed otherwise, suggesting sister relationships for J. navicularis and J. brevifolia (Adams 2008, Adams et al. 2010a). Rumeu et al. (2011), although based on two plastid regions only, confirmed such a sister relationship, which was recovered in a well-supported clade. Shortly afterwards, Adams & Schwarzbach (2012) based on nrDNA ITS and five plastid DNA regions, recovered J. navicularis in a well-supported clade with J. brevifolia and J. deltooides, while J. oxycedrus and allies, including the Macaronesian taxa J. cedrus and J. maderensis, were clustered in another well-supported clade. Later, Boratyński et al. (2014) explored the biogeography and genetic relationships of J. oxycedrus and related taxa, using SSR loci, concluding that J. navicularis is genetically quite different from its relatives. Finally, Adams et al. (2014) combined integrative information and confirmed the already stated relationship between J. navicularis, J. brevifolia, and J. deltooides (Adams et al. 2014), although uncertainties regarding the evolutionary relationships of several lineages and taxa within the J. oxycedrus group remain (Rumeu et al. 2014). The separation between J. deltooides and J. oxycedrus s.l. (including J. badia) was also confirmed by Romar-Marzio et al. (2017), through analysis of essential oils and comparison of morphometric data. Juniperus navicularis was reported as a diploid species by Romo et al. (2013) and Farhat et al. (2019). A morphological and ecological/chorological analysis was also performed by Diez-Garretas et al. (2017) to distinguish this species from J. oxycedrus and J. macrocarpa. These authors found support for the morphological distinctiveness of J. navicularis, reinforcing its taxonomic status as distinct species within the Mediterranean Junipers group. Whilst different phylogenetic approaches consistently relate this juniper to the Macaronesian-Azorean J. brevifolia, the biogeographical and ecological hypothesis is also supported, since J. brevifolia occurs in mesic habitats (Elias 2007) and J. navicularis grows normally in inland, thermomediterranean Atlantic areas (Rivas-Martínez et al. 2017), confirming the biogeographic connection of lineages that links the Macaronesian archipelagos to the Iberian Southwest, already suggested by different works (De Mera et al. 1997, Latorre & Cabezudo 2006, Vila-Viçosa et al. 2020, Vila-Viçosa & Arsenio 2021, Vila-Viçosa 2023). Overall, congruence between biogeography, ecology and phylogenetics suggests that J. navicularis and J. brevifolia belong to a Macaronesian-Iberian disjunct lineage having higher soil moisture and low temperature sensitivity, therefore with relict environmental features.

Because of the taxonomic and phylogenetic uncertainty regarding Juniperus sect. Juniperus, and lacking a proper typification of J. navicularis, a review including the historical study of specimens cited by all authors involved in its adscription to different taxonomic ranks is necessary. Thus, this paper aims to correctly identify, by the typification of the name, this Iberian endemic and threatened micro-tree (Diez-Garretas et al. 2017) and contribute to future studies that will help to unveil the taxonomic and phylogenetic relationships among this cryptic and important group of conifers from the Macaronesian-Mediterranean Macro-Region.
Materials and methods

The designation of the lectotype is based on the study of Gandoger’s specimens, kept in the herbarium of the Université Claude Bernard in Lyon (LY) and the literature cited in the protologue (Gandoger 1910). Supplementary specimens that were mentioned in the protologue and deposited at LISU, COI, PO and H, were also studied. The typification follows the International Code of Nomenclature for algae, fungi, and plants (Turland et al. 2018).

Author names and abbreviations follow IPNI (www.ipni.org) or Phytotaxa guidelines, when necessary and the codes of consulted herbaria are indicated according to Index Herbariorum (Thiers, B. M., updated continuously, http://sweetgum.nybg.org/science/ih/).

Results and discussion

Background and typification of the name

Juniperus navicularis was described by Gandoger (1910) after a second trip to Portugal and Spain to explore inaccessible Atlantic regions in 1905. Notably, the author suggested a putative relationship of his new species with J. brevifolia in the labels of the studied specimens (LY0772612! and LY0772611!) (Figures 1 and 2). This was stated in schedulis: “An species nova prope J. brevifoliain Ant. (e Madera)” and “Affinis J. brevifolieae Ant. (e Madera et Azor)” (Figures 1 and 2). The author had first labeled the specimens as J. umbilicata and acknowledged in the protologue that the plant was reported by other Portuguese botanists as J. macrocarpa. Previously, Coutinho (1909) identified these plants as J. oxycedrus var. brachyphylla Loret in Billot (1861: 282), as populations possessing mostly non-pruinose cones with 6-12 mm in diameter and occurring from coastal Alentejo to near Setúbal, including specimens collected by Welwitsch and reported by Parlatore (1864). In the same work, Coutinho (1909) identified the junipers from the Tagus River, with pungent and larger leaves (18 × 10 mm wide) as J. macrocarpa (Coutinho 1909). On the other hand, Sampaio (1910, 1913) initially identified the specimens from Coastal Alentejo as J. macrocarpa due to their habitat and the shorter leaves, when compared with those from the Douro basin (Northeast Portugal). However, the author (Sampaio 1910, 1913) gave an erroneous cone size of 12-15 mm, which he later decreased into 6-9 mm, when referring to the coastal Alentejo populations (Sampaio 1922). Here, the author stated for the first time that these populations could be a geographical “race” of J. macrocarpa (Sampaio 1922), but he did not publish validly any new combination (art. 36.1). Instead, he listed the southwestern Portuguese populations under the name J. rufescens Link (nom. illeg., Art 38.1) in Kunze (1846: 579), based on the work of Endlicher (1847). Coutinho (1926) was aware of Gandoger’s name and refuted that the plants from Alentejo belonged to J. rufescens var. brachyphylla, although he later proposed the combination J. oxycedrus subsp. rufescens (Link) Coutinho in his Flora de Portugal (Coutinho 1939). This name was already validly published by Debeaux (1894), based on specimens from Kabylia (Algeria), turning Coutinho’s combination illegitimate as a later homonym of the former name. The name J. rufescens itself is illegitimate, as it was meant to be a replacement name for J. oxycedrus to prevent further confusions with J. macrocarpa, thus becoming a superfluous synonym. Nevertheless, J. oxycedrus subsp. rufescens (Link) Debeaux is not illegitimate, as it has a different type than J. oxycedrus L.

Later, Franco (1963) formalized a proposal to classify this taxon (J. navicularis Gand.) at the subspecific rank with a new name, J. oxycedrus subsp. transtagana Franco (1963: 166). This proposal was done disregarding Gandoger (1910) and was supported by specimens cited by Coutinho (1909) (Figure 3). The subspecific status was chosen because of the similarity of the cones to those of J. oxycedrus, although its quite specific ecology was recognized, related to Pleistocene sands from the Tagus-Sado Cenozoic basin (Carvalho et al. 1983, Neto et al. 2007). Later, Silba (1984) proposed the combination J. oxycedrus var. transtagana (Franco) Silba (1984: 35), and finally, Franco (1986, 1993) recognized J. navicularis in both Flora Iberica and Flora Europea as a southwestern Iberian endemic juniper.
FIGURE 2. Isolectotype of *Juniperus navicularis* Gand. (1910: 55) LY0772611!, Herbier LY, Fr BioEEnVis, UCB Lyon 1.
FIGURE 3. Holotype of Juniperus oxycedrus subsp. transtagana Franco (1963: 166) (LISU3001!).
Description

*J. navicularis* has leaves of 4–12 × 1–1.5 mm, which are patent, lanceolate, concave (navicular), attenuated from the middle, sometimes mucronated, with stomatal bands wider than the central green band and round cones up to 10–12 mm with three seeds, very rarely 4 or 5. It can thus be readily separated from *J. oxycedrus s. str.*, which also has cones up to 10–12 mm (but generally smaller), because the leaves of the latter are longer, 8–20(–25) × 1–1.5 mm, with a pungent mucron in all stages of development and stomatal bands as wide as the central green band, which is prominent. The cones very often have more than three larger seeds (*ca.* 6 × 5 mm). As was pointed out above, it can be distinguished from *J. macrocarpa* because this one has cones (10) 12–18 mm wide, often pruinose, with a foul smell, and leaves 20–25 × 2–2.5 mm, lanceolate in shape, with the widest point towards the middle and attenuated into a prickly mucron, more evident in young trees. The seeds are quite distinct, generally ovate, longer but narrower (7 × 4.6 mm) (Franco 1986, pers. obs.).

*Juniperus navicularis* is a name that needs to be typified. As stated above, Gandoger did not cite any specimens, nor any herbarium, but three collections near Lisbon, done by Moller (Coina), Daveaux (Troia) and Gandoger himself (between Alcácer do Sal and Grândola). Following the art. 7.11 example 13 and note 1 of art. 40, we proposed all specimens of those collections as syntypes. While we have been able to locate several specimens belonging to those collections, among them, the specimens from LY are the best preserved original materials. We designate LY0772612 as the lectotype, as this specimen mirrors the species morphological description, based in the leaf and fruit dimensions. Moreover, the label explicitly mentions *In Schedula “Extremadura, Alcacer do Sal in pinetis arenosis ad viam versus Grandola*, which is congruent with the original protologue (Gandoger 1910).


*Juniperus oxycedrus* subsp. *transstagana* Franco (1963: 166)

Type (Holotype, Franco (1963)):—PORTUGAL, Extremadura: Alcochete, August 1906. *António Pereira Coutinho* s.n. (LISU-3001!).

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