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Chenopodiastrum (Amaranthaceae *s. lato*/ Chenopodiaceae *s. stricto*) on Atlantic islands

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Three endemic species of the genus *Chenopodiastrum* occur on remote Atlantic islands: *C. coronopus* on the Canary Islands (El Hierro, Gran Canaria, La Palma and Tenerife), *C. helenense* (Aellen) Uotila, *comb. nova* on Saint Helena, and *C. selvagense* Uotila, *sp. nova* on the Selvagens Islands (Selvagem Grande and Selvagem Pequena) and the Desertas Islands (Ilhéu Chão). The closest relative to all of them is widespread *C. murale*, which is more or less common on many Atlantic islands. Variation in *C. murale* is discussed, morphological descriptions of all the species are given, and their chorological histories on the Atlantic islands are discussed.

Introduction

The large heterogeneous Linnaean genus *Chenopodium* (Amaranthaceae *s. lato*/Chenopodiaceae *s. stricto*) was recently divided into several segregate genera (Fuentes-Bazan *et al*. 2012), including the small genus *Chenopodiastrum*. Originally only five species were included in *Chenopodiastrum*: *C. hybridum* from Eurasia; the related *C. badachschanicum* from Asia; *C. simplex* from North America; the Macaronesian endemic *C. coronopus*; and the widespread *C. murale*. Three more species were later transferred from *Chenopodium* to *Chenopodiastrum*: the tropical African *C. fasciculosum* (Mosyakin 2013); *C. erosum* from Australia and New Zealand, and *C. gracilispicum* from China and Korea (Uotila 2017). However, the transfer of *C. gracilispicum* is doubted due to the recent molecular results to be published in a forthcoming paper. One more transfer and the description of a new species are included in this paper, which means that the genus consists of at least nine species.

Both *Chenopodium* and *Chenopodiastrum* are morphologically very variable and in Fuentes-Bazan *et al*. (2012) there are only a few characters distinguishing them as genera. The description of the genus *Chenopodiastrum* was emended and the most important characters were discussed by Uotila (2017). The new taxa described and combined in the present study were taken into consideration in Uotila (2017).

Material and methods

This study is a continuation of long-lasting research on *Chenopodium s. lato* (e.g., Uotila 1997, 2013, 2017, Uotila & Lomonosova 2016). It was carried out mainly in 2016–2020 based on herbarium material in BM, G, H, K, LE and P. The variation of *Chenopodiastrum murale*, the most

widespread species in the genus, had already been studied globally based on extensive herbarium material, including from B, C, E, FI, KUH, LD, M, MA, MHA, MW, O, S, UPS, W, WU and Z.

Taxonomy

Important diagnostic features of the genus *Chenopodiastrum* include presence of small articulated trichomes and early and completely collapsing vesicular trichomes; the characteristic perianth which is basally connate at most up to half of its length and the segments of which have a tubercle-like abaxial appendage near the apex, the usually prominent mid-vein and the membranous margins, which are entire, crenate or laciniate, mostly minutely ciliate and often more or less bifid at the apex; horizontal seeds, which are lenticular and round in outline and in many species acute or with a narrow wing at the margin. The species are non-aromatic, but at least in some species fresh plants have a characteristic spicy smell. Four species are treated in this paper (Table 1 and Fig. 1).

Chenopodiastrum coronopus (Moq.) S. Fuentes, Uotila & Borsch (Figs. 1a and 2)

Willdenowia 42: 14. 2012. — *Chenopodium coronopus* Moq. *in* de Candolle, Prodr. 13(2): 76. 1849. — TYPE (lectotype, designated by León *et al*. 1982; cited as holotype, correctable to lectotype according to Art. 9.10 of the ICN: Turland *et al*. 2018): "*Chenopodium coronopus* Moq. in DC. Prodr. t. 13

Table 1. Important characters of *Chenopodiastrum coronopus*, *C. selvagense*, *C. murale* and *C. helenense*.

	C. coronopus	*C. selvagense*	*C. murale*	*C. helenense*
Size (cm)	up to 50	up to 35	up to 80	up to 100
Leaf blade	to 50 × 20(25) mm, lanceolate, deeply pinnatipartite, undivided part linear to linear-lanceolate; lobes linear, entire or with a few acute secondary lobes or teeth	to 50 × 25 mm, ± ovate, incised to pinnatifid, undivided part lanceolate to narrowly ovate; lobes linear to linear-ovate or narrowly triangular, ± entire	to 90 × 65 mm, ± ovate to broadly triangular-ovate, entire, irregularly dentate to serrate, teeth obtuse to acute or acuminate, sometimes mucronulate	to 65 × 45 mm, trullate to ovate, ± entire, ± dentate with a pair of larger, lobe-like teeth in basal half, otherwise regularly dentate, teeth mostly acute, mucronulate
Inflorescence	leafy, terminal and axillary, with fairly short branches; glomerules mostly closely set	leafy, mostly axillary, with short branches; glomerules closely set	leafy, axillary and terminal, mostly with short branches; glomerules mostly closely set	leafless, terminal, with elongated branches; glomerules mostly well-spaced
Perianth	connate 1/4–1/3 of length; segments narrow, not contiguous, margins broadly membranous, dentate to laciniate, ciliate	connate 1/2 (sometimes more) of length; segments broad, contiguous, margins membranous, crenate to slightly dentate, sparsely ciliate	connate 1/3–1/2 of length; segments broad, contiguous, margin ± membranous, entire to slightly dentate, more or less ciliate	connate 1/3–1/2 of length; segments broad, contiguous, margin narrowly membranous, crenate to slightly dentate, more or less ciliate
Pericarp	thickish, fairly firmly adhered	thin, fairly firmly adhered	thin, fairly firmly adhered	thin, often fairly easily scraped off
Seed				
diameter (mm)	(0.9)1.0–1.2	1.0–1.3(1.4)	(1.0)1.1–1.3(1.4)	1.0–1.2(1.3)
margin	weakly winged or acute	acute or weakly winged	distinctly winged to acute	acute or weakly winged
Seed coat	minutely pitted to rugulose	rugulose to unclearly pitted	minutely pitted to rugulose	minutely pitted

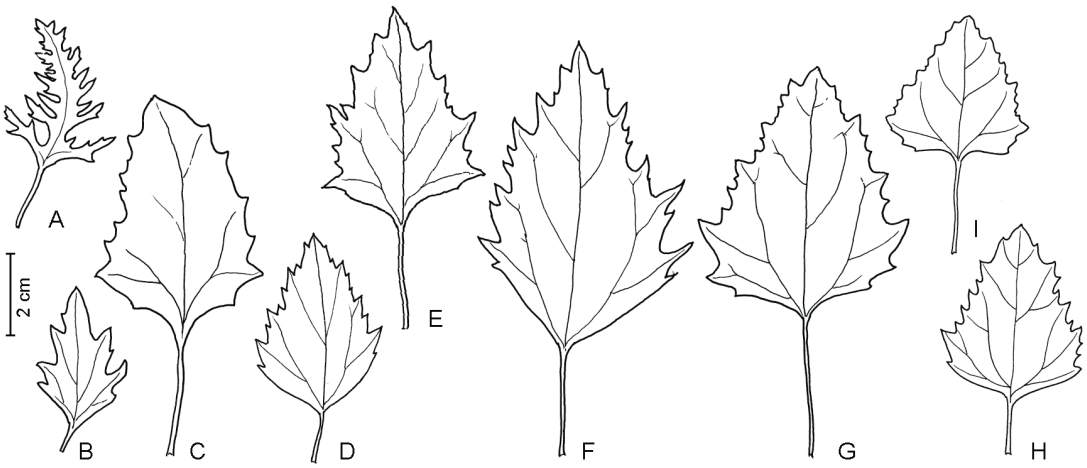

Fig. 1. Drawings of typical middle leaves of the *Chenopodiastrum* taxa treated in this paper. — **A**: *C. coronopus* (Spain, Canary Islands, Tenerife, Buenavista el Fraile, 1949 *B. Pettersson*, H17104515). — **B**: *C. selvagense* (Portugal, Madeira, Ilhéu Chão, 1957 *M. Malmberg*, H1075141). — **C**: *C. helenense* (St. Helena, 2010 *P.W. Lambdon* & *Darlow PL2010#13*, K). — **D**–**I**: *C. murale*. (**D**: St. Helena, *W. Burchell* 87, K000298547; **E**: Namibia, Hereroland, *M. Rautanen*, Z; **F**: Greece, Rhodes, 2007 *H. Väre*, H1739155; **G**: Serbia, 2009 *P. Uotila 48222*, H1746239; **H**: Greece, Athens, 1921 *Vestergren*, S; **I**: Greece, Nauplion, 1976 *A. Palmén*, H1211711). Drawings by Marja Koistinen.

Fig. 2. *Chenopodiastrum coronopus*. Spain, Canary Islands, El Hierro, 21 March 2013. Photo by Arto Kurtto.

ined.; no. 3 Moq.; Cette petite Chénopodée est très rare je l'ai bien cherché je ne peut trouver que le seul exemplaire; la Isletta de Gde Canaria, 11. mars 1846, *Bourgeau* s.n." (FI, Herbarium Webbianum; image in JSTOR Global Plants!). — Isolectotype: "*Chenopodium coronopus* spec. nov.; no. 3 Moq.; petite Chenopodée (?) très rare elle est annuel. Canaria Isleta – In arenis littora, mars 1846; *M. Bourgeau*" (P00083265, Herbarium A. Moquin-Tandon!; image in JSTOR Global Plants).

Stems up to 50 cm, ascending or erect, branched, ridged, sometimes red; young stems, leaves and rachis densely covered with vesicular trichomes, which later collapse, and stems and leaves become glabrescent. Leaf petiole to 30 mm long; blade mat, dark green or slightly brownish, thickish, to 50 × 20(25) mm, lanceo-

late, deeply pinnatipartite, undivided part linear to linear-lanceolate, lobes 3/4–4/5 of blade width, linear, often slightly incurved, entire or with a few acute secondary lobes or teeth, apex acute, mucronate. Inflorescence terminal and axillary, largely leafy, much branched, branches fairly short, with flowers usually in closely set, very small glomerules. Flowers subsessile, perianth basally connate 1/4–1/3 of its length; segments obovate to lanceolate to oblong, not contiguous, spreading to reflexed in fruit, margins broadly membranous, dentate to laciniate especially apically, ciliate, back with a prominent short, flat keel (to 0.15 mm high) near apex, midrib flat, visible adaxially. Pericarp thickened, brown, fairly firmly adhered to seed. Seeds (0.9)1.0–1.2 mm in diameter, 0.5–0.6 mm thick, margin weakly winged to acute; testa blackish, minutely pitted to rugulose. 2n = 18 (Suda *et al.* 2005). — ILLUSTRATIONS: Pérez de Paz *et al*. (1981).

Moquin-Tandon (1849) described *Chenopodium coronopus* from only one gathering, that by Bourgeau from Gran Canaria made in 1846. The sheet in Herbarium Webbianum (FI) includes his information that he had seen only one specimen and a detailed handwritten species description; Bourgeau's handwritten label bears the exact collection date 11 March 1846 (León *et al.* 1982). The description is essentially the same as the one published later (Moquin-Tandon 1849). Probably Moquin-Tandon kept part of Bourgeau's specimen in his herbarium, at present in P. This sheet has rather less collecting information than the sheet in FI; in addition, it includes Moquin-Tandon's original drawings of the floral characters of *C. coronopus*.

Chenopodiastrum coronopus is endemic to the Canary Islands, as stated by Mesa-Coello and Marrero-Gómez (2006), and they considered it critically endangered. It has been found from El Hierro, La Palma, Tenerife and Gran Canaria (*see* http://ww2.bgbm.org/euroPlusMed/PTaxonDetailOccurrence.asp?NameId=7300049&PTRefFk=7300000). According to Stierstrofter and von Gaisberg (2006) it was reported from El Hierro from 18 UTM 1-km^2 grid cells, mostly in the south and west of the island, and in March 2013 the population on El Hierro was quite abundant (A. Kurtto pers. comm.). *Chenopodiastrum coronopus* is mostly sporadic, and grows on bare volcanic sandy soils, often along paths and roads, but, in contrast with *C. murale*, it has not been found in places rich in nitrogen (A. Santos Guerra pers. comm.). On the other hand, *C. murale* may grow together with *C. coronopus*.

Press and Short (1994) and Borges *et al*. (2008) erroneously mentioned *C. coronopus* also from the Selvagens Islands, because of P. Aellen's determinations of some specimens, which belong to *C. selvagense* (*see* below). According to them *C. coronopus* was possibly present also on Deserta Grande and Ilhéu Chão. Based on these sources *C. coronopus* was recorded as native from Selvagens and "native/presence questionable" from Desertas (*see* http://ww2.bgbm.org/euroPlusMed/PTaxonDetailOccurrence.asp?NameId=7300049&PTRefFk=7300000). Menezes de Sequeira *et al*. (2011) reported *C. coronopus* from Madeira as a Macaronesian endemic species. All these references most probably refer to *C. selvagense*, unlikely to *C. coronopus*.

Chenopodiastrum selvagense Uotila, *sp. nova* (Figs. 1B and 3)

HOLOTYPE: Portugal. Salvages Islands. Little Salvages. Sea level. Stones and sand. 6 February 1959 *C.H.C. Pickering 196* (BM013842020!; Fig. 3); fragment in G (Herbarium P. Aellen 19633!).

As *C. murale*, but stems up to 35 cm, weakly ridged, branched. Leaves short-petiolate, petiole 1/7–1/4 of blade length; blade to 50 × 25 mm, ± ovate, incised to pinnatifid, undivided part lanceolate to narrowly ovate, lobes extending half-way towards mid-rib, linear to linear-ovate or narrowly triangular, often slightly incurved, margins entire or with single teeth, apex obtuse to acute, sometimes mucronulate. Inflorescence leafy, small, mostly axillary, formed of short branches in leaf axils, flowers in small, closely set glomerules. Perianth basally connate half of length (sometimes more); segments broadly ovate, obtuse, often slightly erose at apex, margins membranous, slightly dentate, sparsely ciliate, back fairly flat, with a prominent short keel near apex. Pericarp thin, fairly firmly adhered to seed. Seeds 1.0–1.3(1.4) mm in diameter, round

Fig. 3. Holotype of *Chenopodiastrum selvagense* (BM013842020). Reproduced with permission from the Natural History Museum, London.

in outline, lenticular, margin acute or often narrowly winged; testa black, shiny, rugulose to obscurely pitted, somewhat radially striated. — Illustrations: Press and Short (1994: plate 7, fig. 1, as *Chenopodium coronopus*).

Very limited habitat information is available; plants have been collected from cracks in bare basalt cliff, landslide precipice, sandy shores and open ground, i.e., places without established vegetation cover.

Superficially dissected leaves of *C. selvagense* resemble leaves of *C. coronopus*, but in *C. selvagense* the leaves are incised to pinnatifid, lobes at most half of the blade width and usually simple, without teeth on the margins; in *C. coronopus* the leaves are pinnatipartite or almost pinnatisect and lobes further lobed or toothed. The leaf shape of *C. selvagense* appears more or less intermediate between *C. coronopus* and *C. murale* (Fig. 1). Even though the leaf shape

varies considerably in *C. murale*, I have not seen leaves nearly as deeply lobed as in *C. selvagense* in any of the numerous *C. murale* specimens studied from various parts of the world.

Lowe (1869) listed only *Chenopodium murale* from the Selvagens Islands, which lie only about 300 km from Madeira and 150 km from the Canary Islands. Also later the plants from the islands were commonly identified as *C. murale*. However, in 1965 P. Aellen determined some *Chenopodium* specimens, named as *C. murale* from the Selvagens Islands, all as *Chenopodium coronopus*. This may be the reason why the plants were not closely studied but referred incorrectly to *C. coronopus* by Press and Short (1994) and, following them, Borges *et al*. (2008). The description in the Flora of Madeira (Press & Short 1994) fits quite well with *C. coronopus*, but not with the specimens from the Selvagens Islands. On the other hand the illustration provided in the flora is somewhat schematic, but evidently drawn from a specimen collected from the Selvagens Islands and it clearly shows the characteristic leaves of *C. selvagense*. According to Press and Short (1994) the plants from the islands, given as *C. coronopus*, closely resemble plants known as *Chenopodium murale* var. *spissidentatum* (*see* below). Further, *C. murale* was not known from the Selvagens Islands, but it was found from Ilhéu Chão and Bugio of the Desertas Islands.

Press and Short (1994) mentioned *C. coronopus* also from Deserta Grande and Ilhéu Chão, but with a question mark because of poor quality of specimens. Borges *et al*. (2008) listed it from Desertas with a question mark. These reports may refer to *C. selvagense*. The presence of *C. selvagense* on the Desertas Islands was confirmed, when a good specimen from Ilhéu Chão, 25 km south of Madeira, collected by a Finnish amateur botanist Martin Malmberg in 1957, was located at H. The Desertas Islands, especially the small (1.6 × 0.7 km^2) Ilhéu Chão north of Desertas Grande, are quite inaccessible and lack permanent human populations.

Chenopodiastrum selvagense is endemic to the Selvagens and the Desertas Islands. Several collections are known from both major islands of the Selvagens archipelago in the 1860s, and again in 1959–1969. Selvagem Grande was heavily affected by feral animals (goats, rabbits), introduced plants and other kinds of human activity from as early as the 15th century (Ritsema 2010), and probably lost much of its native flora, possibly also *C. selvagense*, before feral animals were eradicated. On the other hand, Selvagem Pequena never hosted introduced grazing mammals and it is more likely that *C. selvagense* still exists there or on the smaller Ilhéu de Fora nearby. Proper searching for *C. selvagense* should be carried out on the Selvagens and Desertas Islands.

Specimens seen. — **Portugal**. Selvagem Grande: 1863 *Sn C.C. des Koponham* (BM); 1865 no collector (BM); [18]66 *B. Paivas* (BM); 1863 & 1865 [herb.] R.T. Lowe (G, Herbarium P. Aellen 19630, fragment from BM); 17 July 1958 *C.H.C. Pickering 165s* (K, as *Chenopodium murale*). — BM collections were received from Herbarium of R.T. Lowe in 1875, all as *Chenopodium murale.* They were collected by Barao do Castello de Paiva (*see* Lowe 1869). Selvagem Pequena: May 1869 (Herbarium R.T. Lowe, 1875; BM, poor specimen, almost indeterminable); 6 February 1959 *C.H.C. Pickering 196* (BM, as *Chenopodium murale*, fragment in G (Herbarium P. Aellen 19633), as *C. coronopus*); 6 February 1959 *C.H.C. Pickering 177* (BM, as *Chenopodium murale*, det. to *C. coronopus*, P. Aellen 1965); 20 July 1963 (with a note: "Specimens from this area show uncommonly deeply divided leaves and distinctive habit. Perhaps separable from *C. murale* but more material needed"), *Major Pickering* (K5550). Desertas Islands: 20 June 1957 *M. Malmberg* (H1075141, as *Chenopodium murale*).

Chenopodiastrum helenense (Aellen) Uotila, *comb. nova* (Fig. 1C)

Chenopodium helenense Aellen, Feddes Repert. Spec. Nov. Regni Veg. 227: 335. 1930. — Type (lectotype, designated by Cronk 2000): St. Helena, Longwood, Bot. Gar. 12 April 1810 *W.J. Burchell* 85-1 (K000195668!, image in JSTOR Global Plants), fragment in G (Herbarium P. Aellen 17297!).

Stems to 100 cm, erect, branched, often with several long branches, stem and branches hard, ridged. Leaves long-petiolate; blade to 65 × 45 mm, trullate to ovate, often slightly three-lobed, ± dentate with a pair of larger, lobe-like teeth in basal half and a few smaller lateral teeth, teeth mostly acute, ± mucronulate, base cuneate to attenuate, apex acute to obtuse; upper leaves narrow, often more dentate, teeth acute; young leaves densely farinose below, almost glabrous above. Inflorescence leafless, terminal, branches

elongated, upright to spreading, often arching; flowers in small, mostly well spaced glomerules. Perianth green, basally connate ca. 1/3–1/2 of length; segments contiguous, broad, with narrow membranous, slightly ciliate margins, wider and slightly dentate-laciniate at apex, back rounded with moderate prominent keel near apex, mid-vein adaxially strong, elevated. Pericarp often fairly easily scraped off from seed. Seeds black, lustrous, 1.0–1.2(1.3) mm, round in outline, thickish, margin acute to weakly winged; testa densely minute-pitted, weakly striated.

Aellen (1930) described *Chenopodium helenense* as species endemic to St. Helena on the basis of six specimens collected by William John Burchell (1781–1863). All specimens bear Aellen's determination labels, dated 22 December 1929 and with the name "*Chenopodium helenianum* Aellen", one with an addition "*spec. nov.*" (the corresponding fragment in his herbarium bears the note "Orig."). Probably he intended this specimen, *Burchell* 86, as the type. But even though he listed the specimens in Aellen (1930) he did not indicate any type specimen in the article, and Cronk (2000) selected *Burchell 85-1* as the lectotype. The latter specimen is more complete and a better choice as the type of *C. helenense*.

The lax inflorescence of *Chenopodiastrum helenense* with long, arched branches is unknown in *C. murale*. Also the leaf shape differs from that of *C. murale*: the leaf blade in *C. helenense* is often somewhat three-lobed, the base tends to be cuneate, and the few teeth are outward projecting. Aellen (1930) noted that teeth of leaves end with a mucro and that the seed testa ornamentation deviates from that of *C. murale*. However, tiny mucros are not uncommon in the leaves of *C. murale* in some areas. Differences in seed testa are weak and Lambdon (2012) stated that seeds of *C. helenense* and *C. murale* are virtually similar. However, in *C. helenense* the pericarp seems to be often loosely attached and the seed surface possibly more distinctly pitted and rugose as in *C. murale*. But more seeds should be studied to confirm this. Lambdon (2012) added some other characters which seem to differentiate *C. helenense* from *C. murale*, such as the yellowish colour and lack of red in stems, and the more fleshy leaves, which when young are more farinose below.

Burchell lived on St. Helena in 1808–1810, first as merchant then as botanist, and he established a local Botanical Garden at Longwood (Cronk 1988). He collected plants from various parts of the island and from the Botanical Garden. In 1811 Burchell travelled to Africa and in 1815 to his home at Fulham near London. There he cultivated plants from seeds brought by him from Africa (Cronk 1988, http://apps.kew.org/herbcat/gotoBurchell.do).

Burchell collected three specimens of unknown *Chenopodium* from St. Helena, Longwood, "near the sea shore" in 1808 (no. 85, 86), and "Bot. Gar." [Botanical Garden] in 1810 (no. 85-1). The last represents a cultivated plant, according to his notes (Burchell W.J. 1806–1808: *Flora Heleniana Manuscripts*, 1806–1810: *Flora insulae Sta. Helenae*; unpublished manuscripts in Kew Archives). Burchell cultivated *Chenopodium* and it became then 3 feet (90 cm) tall. The number 85-1 may refer to the origin of seeds from no. 85. He was unsure of the identity of the specimens, named no. 85 as "*Chenopodium* sp. – *viridis*" and added a long description to his notes on the 1808 specimen (Burchell, ms.). The specimen no. 86 was collected from the same place and was red in colour and received the name "*Chenopodium* sp. – *coccinea*". Hemsley (1885) cited Burchell's specimens as *Chenopodium* sp. and suspected that "they are introduced, and probably varietas of *Chenopodium murale*".

The three other specimens, collected in 1819, 1821 and 1822, are plants cultivated in Burchell's garden at Fulham from seeds brought from St. Helena. The specimens were named only as *Chenopodium*, except for the oldest one which has a text "*Chenopodium n. s. viride – biennis. Folia concaviuscula*", which also tells us that Burchell was still wondering about the identity of his plants. Also the curatorial labels and determinations added later to Burchell's specimens reveal uncertainty, including "*Chenopodium murale* var. ?", "*Chenopodium an C. urbicum* var. ?", "*C.* cfr. *rubrum*", and "*Chenopodium* cfr. *ficifolium*". Noteworthy is that the plants cultivated at Fulham under climatic conditions different from St. Helena, have inflorescence, branching habit and leaf shape similar to the plants from St. Helena.

Chenopodiastrum helenense might have been included in the 19th century records of *Chenopodium murale* and even of *C. album*, which may resemble *Chenopodiastrum helenense* quite closely. William Roxburgh (in Beatson 1816: 295–326) mentioned *Chenopodium album* and *C. viride* from St. Helena. Melliss (1875) listed *C. murale*, *C. album* and *C. album* var. *viride* and reported *C. murale* as "one of the most common and abundant weeds about the forests, and high land generally. It makes a very good substitute for spinach, and is much used as such." These reports indicate two or three different taxa, one of which might be *Chenopodiastrum helenense*. I have not seen verified reports of *Chenopodium album* from St. Helena.

Cronk (2000) followed Aellen and treated the taxon as an endemic species, but without a clear opinion of his own about the taxonomic rank. Lambdon (2012) concluded that probably *C. helenense* is a young species developed from some early arrival of *C. murale* but the species level is preferable because of a set of characters, which make it quite safe to determine the plants in the wild, and possible difference in breeding behaviour and ecology. According to him *C. murale* may occur in populations of *C. helenense* and he was concerned about the possibility of their hybridizing. However, he did not mention any specific case of questionable hybrids. Currently I prefer the species level, but there is no doubt that *C. helenense* is closely related to *C. murale*.

Aellen (1930) paid attention to the fact that there was no collection after Burchell's specimens and he supposed that *C. helenense* belongs to those native species of this remote island that have disappeared because of European settlement. Also Clifton (1996) supposed extinction. However, the surviving of *C. helenense* to the present day was proved when the plant was seen at one locality by Cronk (2000), and later it was considered very rare and noted from four grid cells of the 1-km^2 grid system of the island (Lambdon 2012).

Specimens seen. St. Helena, Longwood, 17 December 1808 *W.J. Burchell 85* (K000243862, as *Chenopodium sp. – viride*), *W.J. Burchell* 86 (K000243861, as *Chenopodium sp. – coccinea*; fragment in G, Herbarium P. Aellen 24625, as *Chenopodium helenianum* (Orig.)); Longwood, 12 April 1810 *W.J. Burchell 85-1* (K000195668, as *Chenopodium Planta viridis*, *3–4 pedalis*); no date, *W. Burchell* (P04994375, as *Chenopodium murale* ? L. var.!) [Received from Kew 1867, the label written at K]; S. Ridge of Prosperous Bay Plain, 1 October 2008 *R. Carins-Wicks RCW2* (K000369837); Bone Gully, 1 October 2008 *R. Carins-Wicks RCW3* (K000369846); Asses Ears, 8 August 2010 *P.W. Lambdon* & *A. Darlow PL2010#13* (K000816060). [England, London], *ex* H Sta. Helena, *Ex* horti proprio Fulham, 4 July 1819 (K000368006, as "*Chenopodium n. s. viride – biennis. Folia concaviuscula*"; London, Fulham, *ex* S from Longwood St. Helena [Cultivated in the garden of J. W. Burchell] 12 August 1822 (K000368007); London, Fulham, *ex* S Longwood, St. Helena [Cultivated in the garden of J. W. Burchell] 31 October 1821 (K000195669). — Obviously two more specimens belong here: St. Helena, 1853 *N.I. Andersson* (G, Herbarium P. Aellen 8307, fragment from S, as *C. murale*); Ladder Hill, October 1955 *N.R. Kerr 104* (BM; fragment in G, Herbarium P. Aellen 19631, as *C. murale* det. P. Aellen 1965).

Chenopodiastrum murale (L.) S. Fuentes, Uotila & Borsch (Fig. 1D–I)

Willdenowia 42: 14. 2012. — *Chenopodium murale* L., Sp. Pl.: 219. 1753. — Type (lectotype, designated by Brenan 1954): Herb. Linn. 313.6 (LINN!).

Stem to 80 cm, erect, variously branched, green to yellowish, seldom with red; stem and branches weakly ridged. Leaves with 20–50 mm long petiole, usually 1/3–1/2 of blade length; blade to 90 × 65 mm, ± ovate to broadly triangular-ovate, dentate to serrate, sometimes with slightly larger basal teeth, teeth usually varying in size, obtuse to acute sometimes acuminate or mucronulate, base (broadly) cuneate to rounded, apex acute to obtuse. Upper leaves narrow, dentate to serrate. Young leaves densely farinose below, almost glabrous above. Inflorescence lateral and terminal, branches short, spreading, often arching; flowers in small, mostly closely set glomerules. Perianth green, basally connate ca. 1/3–1/2 of length; segments broad, contiguous, with narrow membranous, slightly ciliate margins, wider and slightly dentate-laciniate at apex, back rounded with moderate prominent short keel near apex, mid-vein adaxially strong, not elevated. Pericarp fairly firmly adhered to seed. Seeds black, lustrous, (1.0)1.1–1.2(1.4) mm, 0.7–0.8 mm thick, round in outline, fairly flat, margin with distinct wing or acute; testa shiny, black, minute-pitted to rugulose, radially some-

what striate. 2n = 18 (numerous counts; *see* Grozeva & Atanassova 2019).

Chenopodiastrum murale is one of the most widespread chenopods in the world, occurring in all continents except Antarctica. Its native area is obscure due to obvious anthropochorous spreading already centuries ago. It is very variable, especially in the leaf shape, and several varieties and forms have been described by P. Aellen and earlier authors, but subsequent authors have not paid very much attention to this variability. Murr (1903) described from Egypt *C. murale* var. *spissidentatum* with long, narrow and acute teeth on leaves. Such plants (Fig. 1F) are quite common in northern Africa, eastern Mediterranean area and found also further east and southeast; *Chenopodium ilicifolium* (originally published as "*ilecifolium*", an orthographical error correctable under Art. 60.1 of the ICN: Turland *et al*. 2018) from Afghanistan (Griffith 1854a, 1854b) probably represents this variety. When revising South African chenopods Aellen (1928) noted that most of specimens of *C. murale* differed from the European plants in having somewhat thicker leaves with acute teeth. He described these plants as *C. murale* var. *acutidentatum*. The variety was accepted in the Cape Flora (Adamson 1950), otherwise omitted. Aellen did not compare these varieties and later (Aellen 1931, 1960) considered var. *spissidentatum* to be only a form and finally did not mention either of them in *Prodromus einer Flora von Südwestafrika* (Aellen 1967). Brenan (1954) included this form in the normal range of *C. murale*. However, Press and Short (1994) discussed var. *spissidentatum* when trying to understand the plants growing on the Selvagens Islands.

The variation in the leaf shape of *Chenopodiastrum murale* seems to have some geographical pattern, even though complicated by centuries-old human transport of seeds of *C. murale* between countries and continents. Plants of *C. murale* with ± serrate leaves with often dense, narrow and acute teeth (Fig. 1D–F), dominate at least in southern Africa and are common on the Atlantic Islands and Mascarene Islands, but such specimens have been seen also from the Mediterranean area in southern Europe, northern Africa and SW Asia, the Arabian Peninsula, North and South America and Australia. In the south (Fig. 1D and E) the teeth are typically less variable in size than in the Mediterranean area (Fig. 1F). Instead, most European plants have ± dentate, broad and often obtuse teeth (Fig. 1G–I). This variation of *C. murale* needs more attention and study to evaluate its importance.

Distribution on Atlantic Islands. — **Azores**. *Chenopodiastrum murale* is the only species of the genus on the Azores and obviously introduced as stated by Menezes de Sequeira *et al*. (2011). It was treated as native by Uotila (*see* http://ww2.bgbm.org/euroPlusMed/PTaxonDetailOccurrence.asp?NameId=7300048&PTRefFk=7300000), based on the old information in *Flora Europaea* (Brenan & Akeroyd 1993). The specimens seen represent both leaf types. — **Madeira**. According to Press and Short (1994) and Carvalho *et al*. (2013) *C. murale* is common on Madeira and Porto Santo, and it is also found on Ilhéu Chão and Bugìo. It is commonly accepted as native, also by Menezes de Sequeira *et al*. (2011). Many specimens seen from Madeira represent plants with more or less serrate leaf margin and some also approaching intermediates between *C. murale* and *C. selvagense*. — **Selvagens Islands**. De Nóbrega (1955) reported *C. murale* from several places on Selvagem Grande, within colonies of introduced *Suaeda fruticosa* and *Nicotiana glauca*, but these records may refer to *C. selvagense* as well. Also Hansen (1969) listed *C. murale* as the only *Chenopodium* (*s. lato*) from the Selvagens Islands. Monod (1990) accepted only *C. murale* from Selvagem Grande, Selvagem Pequena and Ile Foro. However, two different taxa may be included because he mentioned that some of the specimens resemble *C. murale* var. *spissidentatum*. According to Press and Short (1994) *C. murale* was not known from the Selvagens Islands; they included the local species in *C. coronopus*. I have not seen any typical specimen of *C. murale* from the Selvagens Islands. However, one of the specimens collected by Pickering (no. 177) has two typical plants of *C. selvagense* and one which could be a hybrid between *C. selvagense* and *C. murale*. — **Canary Islands**. *Chenopodiastrum murale* is known from all major islands of the archipelago and is a common weed. It is regarded as probably introduced (e.g. Arechavaleta *et al*. 2010). Stierstorfer and Gaisberg (2006) reported

C. murale as the most frequent chenopod on El Hierro and consider its status there uncertain because it commonly grows in both anthropogenic and natural communities. Many of the specimens seen from different islands of the Canary Archipelago have serrate leaf margins but plants with typical morphology of European plants are common, as well. — **Cape Verde Islands**. Cape Verde Archipelago, ca. 600–870 km off the coast of Senegal, was discovered in the mid 1400s and since then has been gradually intensively cultivated, grazed and densely populated, and now has lost much of its original flora and vegetation, but on the other hand has received a great number of introduced species. Already Chevalier (1935) reported *Chenopodium murale* as common in the archipelago, both as spontaneous and ruderal in the vicinity of settlements, on cultivated ground and seashores. Sánchez-Pinto *et al*. (2005) list it as introduced from all the 12 islands of the archipelago. I have seen a good many specimens of *Chenopodiastrum murale* from Cape Verde, and both leaf types are represented among them. — **Saint Helena**. Aellen (1930) regarded *C. murale* on St. Helena as an introduced weed like *Chenopodium ambrosioides* (now accepted as *Dysphania ambrosioides*, *see* Mosyakin & Clemants 2002 and Fuentes-Bazan *et al*. 2012), the third species of the genus *Chenopodium s. lato* known to him from St. Helena. Probably he saw only one specimen: St. Helena, *W. Burchell 87* (K000298547!, as *Chenopodium murale*), which bears Aellen's determination slip from the year 1929. As to its ± serrate leaves (Fig. 1D) the specimen matches quite well with typical southern African *C. murale.* The same concerns the specimen collected by Q. Cronk St. Helena in 1 September 1986 (*Q. Cronk* 442; E00318703, phograph!). According to Lambdon (2012) *C. murale* was common on St. Helena, recorded from 56, 1-km^2 grid cells.

Discussion

There are three endemic species of *Chenopodiastrum* on remote African islands of the Atlantic Ocean: *C. helenense* on St. Helena, *C. coronopus* known only from the Canary Islands (El Hierro, Tenerife, Gran Canaria and La Palma) and *C. selvagense* from the Selvagens Islands (Selvagem Grande and Selvagem Pequena) and from the Desertas Islands. Morphologically they are related to the widespread *C. murale*, which together with *Dysphania ambrosioides*, seems to be the most common chenopod species on the southern Atlantic islands, similar to the situation on the Mascarene Islands in the Indian Ocean (Sukhorukov *et al*. 2019).

These endemic taxa differ from *C. murale* and from each other especially in leaf characters. Leaf shapes of the species on different island groups have developed in different directions: leaves of *C. helenense* resemble to some extent *C. murale* or even *Chenopodium album*, whereas *C. coronopus* and *C. selvagense* with their deeply lobed leaves resemble each other but neither *C. murale* nor other *Chenopodiastrum* species. The leaf shape of *C. selvagense* is rather intermediate between *C. murale* and *C. coronopus*, which may refer to hybridogenous origin of the species. As to *C. helenense* its mainly terminal, leafless inflorescence with long branches and well-spaced glomerules differs from the other species, which have a more leafy inflorescence with short branches and closely set glomerules. Furthermore, *C. murale* varies in leaf shape, and significantly often the plants on the islands have ± serrate leaves with acute, narrow teeth of varying size and resemble plants frequent especially in southern Africa and less common in Europe.

In flower and seed characters differences are negligible or slight with considerable overlapping. *Chenopodiastrum coronopus* deviates from the other species more distinctly not only because of leaves but also of the perianth characters. Its perianth segments are not contiguous and have dentate to laciniate margins, whereas in the other species the segments are contiguous and the margins are mostly only crenate to slightly dentate. Even the abaxial keel in the apical part of perianth segments seems to be higher in *C. coronopus* than in other species. Small differences in pericarp and seed characters may exist, but the specimens studied for *C. helenense* and *C. selvagense* were insufficient for proper analysis of flower and seed characters.

Geographical isolation has kept these endemic taxa separate from each other but did not prevent the spreading of *C. murale* to the

islands. It is quite possible that *C. murale* has been introduced also to the Selvagens Islands, where confirmed specimens have not been seen. The morphology of *C. murale* on the Atlantic Islands strongly points to older or younger southern African origin. Hybridizing with it might threaten the endemic *Chenopodiastrum* species; a possibe hybrid *C. murale* × *selvagense* is suspected from Selvagem Pequena.

All these islands have a similar geological background. They are volcanic in origin, and on the Cape Verde Islands and the Canaries there is still volcanic activity. The numbers of endemic vascular plant species developed there are high: 539 on the Canaries (Arechavaleta *et al.* 2010), 130 on Madeira, 37 on Desertas, and 12 on the Selvagens Islands (Borges *et al*. 2008), 66 on the Cape Verde Islands (Arechavaleta *et al*. 2005), and 49 on St. Helena (Cronk 2000). Basaltic lava and calcareous soils are typical in the open habitats of *Chenopodiastrum*. Such habitats are independent of human activity and allowed the evolution and survival of local *Chenopodiastrum* taxa.

It is worthy of mention that a few endemic island taxa are also known in *Chenopodium* and the segregate genera from the more southern part of the Atlantic Ocean, as *Dysphania tomentosa* (Tristan da Cunha) and from the Pacific Ocean, as *Chenopodium oahuense* (Hawaii; with subsp. *ilioensis*, *see* Cantley *et al*. 2020), *C. sancti-ambrosii* (Desventuradas Islands) and *C. nesodendron*, *C. crusoeanum*, and *C. sanctae-clarae* (Juan Fernández Islands).

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