
The Esparto Grass Question: A Systematic Approach for a Long-Lasting Problem in *Stipa* L. (Gramineae)

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ABSTRACT. The systematic diversity within the esparto grass has produced controversy since the first century AD regarding the varying quality of this natural product as textile material. Investigated herein is *Stipa* subg. *Macrochloa* (Kunth) Barreña, D. Rivera, Alcaraz & Obón. Two species, *Stipa antiatlantica* and *S. tenacissima*, as well as two subspecies within *S. tenacissima* are recognized. *Stipa kralifii* is newly synonymized with *S. tenacissima* subsp. *gabesensis*. A dichotomous key is presented for identification of the taxa.

RESUMEN. La diversidad sistemática del esparto ha dado lugar a diversas controversias sobre la diferente calidad como material textil de este producto natural, desde el siglo I AD. Se investiga el género *Stipa* subgénero *Macrochloa* (Kunth) Barreña, D. Rivera, Alcaraz & Obón. Se reconocen 2 especies, *Stipa antiatlantica* y *S. tenacissima*, así como dos subspecies dentro de *S. tenacissima*. Se incluye *Stipa kralifii* nuevamente en sinonimia con *S. tenacissima* subsp. *gabesensis*. Se presenta una clave dicotómica para la identificación de los taxones.

Key words: esparto grass, Mediterranean flora, Poaceae, *Stipa tenacissima*.

Pliny (Rackham, 1971) wrote in his *Natural History* (first century AD) about esparto grass (also called alfa grass, halfa grass, and Spanish grass) as a valuable product of the southeastern Iberian Peninsula, which was exclusive to this part of the Mediterranean Region. Pliny also stated that a smaller and unprofitable type occurred in Africa. Esparto became at that time a strategic good because its fibers are extremely resistant to rotting in sea water. Therefore, esparto ropes and cordage are excellent for maritime vessels, and they constituted an invaluable product for commercial and military fleets. The most suitable esparto plants were confined to a 30 × 100 square-

mile area near Cartagena (Spain) according to Pliny (Rackham, 1971). The best grade of esparto grass is known as Spanish, while the cheaper African grade is called Tripoli, referring to the capital city of Libya (Roberts & Etherington, 1994). Thus, Spanish *Stipa tenacissima* constitutes the best, main source of esparto fiber. The generic name *Stipa* was coined by Linnaeus and was assumed to come from Latin *stippa* (tow), from the Greek *stuppeion* or *stuppe* (coarse fiber of flax or hemp, tow, oakum), perhaps alluding to plumose awns forming feathery inflorescences or, most likely, to the fiber obtained from esparto grass [Latin *stippa* produced *estopa* in Spanish, *étoupe* in French, and *stupe* in English] (Fowler et al., 1990; Gaffiot, 1984; Hitchcock, 1925; Liddell & Scott, 1996; Rivera & Obón, 1991; Watson & Dallwitz, 2003).

Introduced in England in 1850 by T. Routledge, esparto fiber was used extensively in Great Britain, but was seldom employed in the United States, principally due to the cost of transporting the grass or pulp made from it. In England, it is employed in the production of better grades of book paper. The presence of esparto fiber in paper is determined by an iodine-zinc chloride test, which stains deep violet, or by boiling the specimen in a 1% solution of aniline sulfate, which turns the paper pink in the presence of the grass (Roberts & Etherington, 1994).

Stipa tenacissima L., which traditionally belongs within the genus *Stipa* L., has an Iberian–North African distribution, growing in semi-arid and dry climates, extending to the Balearic Islands. In the Iberian Peninsula, the taxon occurs in the central, eastern, and southeastern regions, although populations also occur scattered along the Algarve region in Portugal. It has been reported from Ibiza and Menorca in the Balearic Islands (Pereira, 1974; Vázquez & Devesa, 1996). In northern Africa *S. tenacissima* extends from southwestern Morocco to Khoms in western Libya; its southern distributional limit is the

northern edge of the Sahara desert (Abdelkrim & Bensettiti, 1988; Le Houérou, 1959a, b; Maire, 1953; Walter, 1977). This taxon is not represented either in Turkey or Cyprus; citations from there (Bor, 1985; Scholz, 1985) are a consequence of misidentifications.

Some authors mistakenly identified “albardin” or “false esparto-grass” from Spain as *Stipa tenacissima* (Zeven & de Wet, 1982). “Albardin” is the common name in Spanish for the monotypic genus *Lygeum* Loeffling ex L. (1754), i.e., *Lygeum spartum* L., also esteemed as a fiber plant (Rivera & Obón, 1991). Although taxonomically distant (*Lygeum* belongs to the tribe *Lygeae* J. Presl), false and true esparto grass are often confused because of their similar uses and their partly sympatric distribution.

The genus *Macrochloa* Kunth comprised only two species: *Macrochloa arenaria* (Brotero) Kunth [= *Stipa gigantea* Link] and *M. tenacissima* (Loeffling ex L.) Kunth. Subsequently, it was submerged within *Stipa* by Steudel (1854), but there is a problem in interpreting Steudel’s infrageneric taxa as subgenera or sections because of his inconsistent use of rank. The uncertain use of the double SS as a symbol for infrageneric supraspecific taxa by Steudel (1854) cast doubt on their circumscription, and traditionally these have been considered unranked. Pfeiffer’s (1873–1874) index of names of taxa above the rank of species accepts Steudel’s infrageneric taxa in *Stipa* as sections, but that interpretation seems arbitrary. Did Pfeiffer actually make the infrageneric combination at the rank of section? It has been suggested to us (Jerrold I. Davis, pers. comm.) that it should be considered as *Stipa* sect. *Macrochloa* (Kunth) Pfeiffer. This has been adopted by Vázquez and Devesa (1996), who combined *Macrochloa* at the rank of section within *Stipa*, including in its synonymy the combination by Steudel at the rank of subgenus. Thus, we have several alternative combinations available, but all doubtful. Freitag (1985) considered *Macrochloa* somewhat isolated within *Stipa*. The type species of section *Macrochloa* was formally designated by Vázquez and Devesa (1996) *Stipa tenacissima* L., and they excluded *Stipa gigantea* Link from this section.

Raffaelli and Ricceri (1989) described three new species (all within the limits of subg. *Macrochloa*) from Tunisia (*Stipa gabesensis* Moraldo, Raffaelli & Ricceri, *S. kelibiae* Moraldo, Raffaelli & Ricceri, and *S. kralifii* Moraldo, Raffaelli & Ricceri). These three species were distinguished using characters such as the presence of trichomes on the palea, glume type (entire or 2-cleft), length of the lobes of the ligules, shape of the leaves (strongly recurved or not), length of the lobes of the lemma, shape of the lodicules, and diameter of the cauline leaves, among others. Vázquez

and Devesa (1996) did not accept most of these characters as useful for the subgenus. The descriptions by Raffaelli and Ricceri (1989) had been based on relatively few specimens but these were enough to raise the question of the homogeneity of the subgenus. For this reason, we analyzed the subgenus in its entirety, covering its entire geographic range.

MATERIAL AND METHODS

We analyzed material from 108 populations of *Stipa* subg. *Macrochloa* from the Iberian Peninsula and Balearic islands (74), and North Africa (34) [specimens collected by us or received on loan for study from ABH, BM, COI, FI, G, LINN, MA, MAF, MUB, RNG, RO, UMH; see Appendices 1, 2], to look for differences among them. Secondly, we examined variability within the taxa, testing also the status of the recently described species (Raffaelli & Ricceri, 1989).

Complete, mature specimens were used for the analysis. Incomplete herbarium specimens were also of great utility when checking the localities of the most significant populations and for broadly defining the geographical range and morphological variability within subgenus *Macrochloa* as a whole. Type specimens were consulted as available. The type specimen of *Stipa tenacissima* L. (LINN 94.7) was studied, but it was not included in our numerical analysis. Nevertheless, its attributes were checked against the results of numerical studies to establish which infrageneric group it belonged to. Linnaeus described the species using mostly plant material collected by Loeffling from the vicinity of Madrid, Spain; thus, we paid particular attention to populations from this area (Vázquez et al., 1995).

We failed to obtain a loan of the holotype specimens of *Stipa gabesensis*, *S. kelibiae*, and *S. kralifii*, which were not found at the herbarium FI in 2000 and 2001. Rather, we did receive most of the material available at FI of these taxa, including isotypes. Surprisingly, a detailed description of the sheets containing the holotypes is given by Vázquez and Devesa (1996) with the correlative numbers of loan from the herbarium FI (3016/1 to 3). Were these never returned to FI? Thus, for the above taxa we only considered the diagnoses and other specimens from the type localities, viz. topotypes. We received from P. Cuccini (FI) negatives of one specimen from Libya (*Pampanini 679*) determined as *Stipa gabesensis* by Raffaelli and Ricceri. Jaakko Nurmi of the Finnish Museum of Natural History extensively and carefully searched for us the type material of *Stipa tenacissima* var. *villosiuscula* Lindberg in H.

The plant material proceeds in part from herbarium loans, although our own gatherings and observations

were also made in the field. Anatomical studies followed the approach of Renvoise (1985), considering especially leaf vasculature of the subsidiary bundles below secondary bundles in transverse blade sections. The measurements and states observed in each sheet were analyzed using the package Syntax 5.1 (Podani, 1994).

RESULTS AND DISCUSSION

Diagnostic characters are summarized in Tables 1 and 2. During our study, taxonomic characters and/or new character-states were confirmed or discovered. For example, it was observed that in the character conforming to the indument of the palea there is a continuous gradient from glabrous to pubescent (Table 2). The presence of long trichomes on and between the adaxial ribs constitutes the most consistent character, although individuals lacking trichomes also appear, even within the same population, and some displayed only scattered trichomes near the apex of the palea (Fig. 1). Other characters, such as the type of glume apex (entire vs. bifid), do not appear to be of taxonomic value because the whole range of variability may be detected within the same specimen, occurring in populations from Toledo, Spain, and Djebel Nafousah, Libya.

Table 1 summarizes those characters that distinguish *Stipa* subg. *Macrochloa* from subgenus *Jarava* and sections of *Stipa* subg. *Stipa*. It should be noted that *Stipa* sect. *Giganteae* comprises the remaining species of two included by Kunth (1829) in genus *Macrochloa*: *Stipa gigantea* Link (in J. Bot. (Schrader) 2: 313. 1799) [= *Macrochloa arenaria* (Brotero) Kunth].

The membranous ligule being replaced with trichomes is the most distinctive character for *Stipa* subg. *Macrochloa*. Geniculate awns with plumose columns, anthers with long lax trichomes (shared only with *Stipa* sect. *Giganteae*), and leaves with subsidiary vascular bundles are further characters relevant for this group (Table 1).

The variability within subgenus *Macrochloa* is well described with two characters: the indument of the palea apex and the indument of the upper third of the leaf sheath. Other useful characters to mention are the leaf type, awn length, length of the column of the awn, as well as the length of the seta of the awn, respectively (Table 2). The remaining characters have lesser relevance to the taxonomy of the group.

The first specimen group of esparto grass, *Stipa antiatlantica*, is characterized by the pubescence on the upper third of the leaf sheaths (Fig. 1a), a character that is unique within *Stipa* subg. *Macrochloa* (Table 2), as well as the palea covered throughout with long trichomes (Fig. 1b). This group was found in

populations from the southern High Atlas, Anti-Atlas, Mogador, and Agadir in Morocco. The presence of scattered trichomes on the palea (Fig. 1c) characterizes a second specimen group, *S. tenacissima* subsp. *gabensis*, whereas the leaf sheath is glabrous. This was found in populations from eastern Algeria, most of Tunisia, and western Libya (Fig. 2), as well as one specimen from Benisicar, Morocco. The third specimen group comprises the type material of *S. tenacissima*, from the outskirts of Madrid, Spain, and similar populations (Fig. 2) with both the palea and leaf sheath glabrous (Fig. 1d, f). The populations of Algarve, Portugal, and the Balearic Islands seem to represent an intermediate variant of the second group above, with a few scattered trichomes near the tip of the palea (Fig. 1e).

Therefore, it is necessary to recognize that *Stipa* subg. *Macrochloa* consists of three fairly homogeneous groups. Each one of these occurs in a well-defined distribution area (Fig. 2) and displays a number of constant characteristics. The overall variability is relatively small, and the characters involved mainly pertain to the type of indument. We recognize two groups as clearly distinct at the species level; within one of these we recognize two distinct groups at subspecies rank (Table 2). The level of species given by authors such as Raffaelli and Ricceri (1989) for *S. kralifii*, *S. gabensis*, and *S. kelibiae* should be discarded.

Stipa antiatlantica is endemic to southern Morocco (Fig. 2). Within *S. tenacissima*, the typical subspecies has the largest extent, covering most of the species' area (Fig. 2). Most of the populations of *S. tenacissima* subsp. *tenacissima* have been established under cultivation, especially in the eastern Iberian Peninsula. The second subspecies, *S. tenacissima* subsp. *gabensis*, is confined to the eastern range of the species' distribution (Fig. 2). The entire subgenus, *Stipa* subg. *Macrochloa* is endemic to the western Mediterranean region (Fig. 2).

TAXONOMIC TREATMENT

***Stipa* L. subgen. *Macrochloa* (Kunth) Barreña, D. Rivera, Alcaraz & Obón, comb. et stat. nov.** Basionym: *Macrochloa* Kunth, Révis. Gram. 1: 58. 1829. *Lasiagrostis* sect. *Macrochloa* (Kunth) Trinius & Ruprecht, Spec. Gram. Stirp. 1: 94. 1842. *Stipa* sect. *Macrochloa* (Kunth) [Steudel ex] Pfeiffer, Nomenclator Botanicus 1: 132. 1873–1874. [*Stipa* (unranked) *Macrochloa* (Kunth) Steudel, Syn. Pl. Glum. 1: 132, 1854.] TYPE: [Spain] *Macrochloa tenacissima* (Loefling ex L.) Kunth, lectotype, designated by Hitchcock, Contrib. U.S. Nat. Herb. 24(7): 216. 1925.

Table 1. Comparison of infragenera within *Stipa* L. The diagnostic characters of *Stipa* sensu stricto in South America, Africa, and the Mediterranean region (Caro & Sánchez, 1973; De Winter, 1965; Freitag, 1985; Hitchcock, 1925; Maire, 1953; Moraldo, 1986; Tovar, 1993; Vázquez & Devesa, 1985; Renvoize, 1985; Tovar, 1993; Vázquez & Devesa, 1996). References for basic chromosome numbers: Vázquez and Devesa, 1996.

Subgenera	<i>Stipa</i>									
	<i>Macrochloa</i>	<i>Jarava</i>	<i>Ptilagrostis</i>	<i>Giganteae</i>	<i>Stipa</i>	<i>Leiotstipa</i>	<i>Barbatae</i>	<i>Inaeoiglumis</i>	<i>Stipella</i>	<i>Aristella</i>
Sections	<i>Macrochloa</i>	<i>Jarava</i>	<i>Ptilagrostis</i>	<i>Giganteae</i>	<i>Stipa</i>	<i>Leiotstipa</i>	<i>Barbatae</i>	<i>Inaeoiglumis</i>	<i>Stipella</i>	<i>Aristella</i>
Habit	perennial	perennial	perennial	perennial	perennial	perennial	perennial	perennial	annual	perennial
Ligules	cespitose replaced by trichomes	cespitose membranous	cespitose membranous, ciliolate	cespitose membranous	cespitose membranous	cespitose membranous	cespitose membranous	cespitose membranous	cespitose membranous	stoloniferous membranous
Glumes	subequal bifid	subequal entire	subequal obscurely bilobed	subequal bifid	subequal entire	subequal entire	subequal entire	dissimilar entire	subequal entire	subequal notched
Lemmas	bifid	entire	obscurely bilobed	bifid	entire	entire	entire	entire	entire	notched
Indument	uniformly pubescent	summit bearing trichomes 3–4 mm long	uniformly pubescent	uniformly pubescent	7 ranks of trichomes	7 ranks of trichomes	7 ranks of trichomes	uniformly pubescent	uniformly pubescent	adpressed trichomes
Callus	acute	—	obtuse	acute	acute	acute	acute	acute	acute	obtuse
Awns	geniculate	once-twice geniculate	slightly twisted	twice geniculate	twice geniculate	twice geniculate	twice geniculate	twice geniculate	twice geniculate	straight, not geniculate
Columns	plumose	scabrous	scabrous	scabrous	glabrous	scabrous or pubescent	scabrous	scabrous or pubescent	scabrous or pubescent	pubescent < 0.5 mm
Setae	scabrous	scabrous	scabrous	scabrous	plumose	scabrous or with trichomes	pubescent	scabrous or with trichomes	scabrous or with trichomes	pubescent with trichomes < 0.5 mm
Paleas	entire	entire	entire	bifid	entire	entire	entire	entire	entire	entire
Anthers	tips provided with tufts of long soft trichomes	—	glabrous	tips provided with tufts of long soft trichomes	glabrous	glabrous	glabrous or with trichomes	glabrous	glabrous	glabrous
Subsidiary bundles	present	lacking	lacking	lacking?	lacking	lacking	lacking	lacking	lacking	lacking
Styles	2	—	—	2	2	2, 3, or 4	2	2	2	2
N ^o basic	x = 12	x = 11	x = 12	x = 12	x = 11	x = 11	x = 11	x = 7	x = 12	x = 7

Table 2. Morphological comparison of characters and character-states for the species and subspecies within *Stipa* subg. *Macrochloa*.

Characters	<i>Stipa antiatlantica</i>	<i>S. tenacissima</i> subsp. <i>tenacissima</i>	<i>S. tenacissima</i> subsp. <i>gabensis</i>
Culm length (cm)	20–155	20–180	45–135
Length of the upper glume (mm)	22–26	21–25	23–26
Length of the lower glume (mm)	25–29	24–30	25–29
Length of the lemma (mm)	8.0–9.2	9.2–10.3	8.8–9.8
Length of the apical lobes of the lemma (mm)	1.0–2.4	1.6–2.2	1.6–2.2
Length of the palea (mm)	7.5–9.0	8.5–9.4	7.5–8.3
Length of the awn (mm)	55–59	47–57	58–73
Length of the column of the awn (mm)	14–15	14–17	19–24
Length of the seta of the awn (mm)	41–46	33–40	39–50
Indument of the upper third of the leaf sheath	pubescent	glabrous	glabrous
Type of leaves	not bent (strict)	bent or not	not bent (strict)
Type of inflorescence	broadly lanceolate	broadly lanceolate to spindle shaped	broadly lanceolate
Indument of the apex of the palea	pubescent	glabrous	pubescent
Rows of trichomes on abaxial ribs of the palea	present	lacking	present
Trichomes between abaxial ribs of the palea	present	lacking	present

Note: Values were assembled from one data matrix of 40 selected specimens × 18 characters and from the type collection study. Some of the specimens used are: *Stipa antiatlantica* (Charpin, Fdez. Casas, Jacquemoud & Jeanmonod MAR 275 (G, MA), Podlech 42788 (G), P. & J. Davis s.n. (BM)), *S. tenacissima* subsp. *tenacissima* (Loefling s.n. (LINN), Rivera s.n. (MAF), García s.n. (MUB), Navarro & Sánchez s.n. (MAF)), *S. tenacissima* subsp. *gabensis* (Davis 49705 (RNG), Davis 49797 (RNG)).

Perennial, densely caespitose; culms 20–180 cm high, herbaceous, unbranched above, 2- to 4-noded; culm nodes violet tinged and pubescent; culm internodes solid; young shoots intravaginal. Leaves mostly basal, auriculate; sheaths glabrous or pubescent; ligule replaced by a pair of trichome tufts, 2–4 cm long on the basal leaves, 1–2 cm long on the upper leaves; leaf blade linear, narrow, strict, or bent, convolute, abaxially glabrous and adaxially pubescent, (0.4)1.0–1.5(2.4) mm wide. Plants bisexual, with bisexual spikelets; with hermaphrodite florets. Inflorescence contracted, paniculate, lanceolate or spindle shaped, 30–40 cm long, not deciduous, with 10 to 30 branchlets and 30 to 80 spikelets, spatheate; spikelet-bearing axes persistent, pubescent, with 1 to 7 spikelets each. Spikelets not secund, pedicellate; bisexual spikelets disarticulating above the glumes; spikelets with hermaphrodite florets only, without proximal incomplete florets. Hermaphrodite florets 1. Pubescent callus present, the callus trichomes white; callus (1.5)1.8–2.1(2.9) mm long, pointed. Glumes two, subequal; upper glume (18)21–26(31) mm and lower glume (20)24–30(39) mm; long relative to the adjacent lemmas, pointed, with long acuminate apices, glabrous, entire, with pubescent veins; lower glume 3(to 5)-nerved; upper glume (3- to)5-nerved. Lemmas lanceolate, (7.0)8.7–10.3(13.2) mm, convo-

lute, subtending the palea, not saccate, without a crown, decidedly firmer than the glumes, usually 2-lobed, lobes (0.8)1.6–2.4(3.5) mm; lemmas pubescent (the trichomes usually ascending, diffuse or in longitudinal ranks), terete and non-carinate, having the margins lying flat on the palea, 3- to 5-nerved; awns 1, from a sinus, geniculate, long plumose, much longer than the body of the lemma, (3.6)4.7–7.3(8.8) cm, entered by several veins arising from the lemma, persistent (but usually jointed at the base); awn bases twisted; awn column with patent trichomes and the seta with short adpressed trichomes; palea subequal and slightly shorter than the lemma, tightly enclosed by the lemma, entire or slightly cleft, awnless, without apical setae; thinner than the lemma, not indurate, 2-nerved, free, palea glabrous, or unevenly pubescent, (7.0)7.5–9.5(12.7) mm; lodicules 3, free, membranous, the anterior usually somewhat different, generally larger, (0.7)1.8–2.2(3.1) mm long; stamens 3, anthers 5–10 mm long, penicillate; ovary glabrous; styles free to their bases; stigmas 2, white. Chasmogamous. Caryopsis free from both lemma and palea, 4–18 mm long, linear, or fusiform, not grooved, compressed laterally; hilum long-linear. Seedling with either a short or long mesocotyl; first seedling leaf with a well-developed lamina, this lamina narrow, erect, 3- to 5-veined.

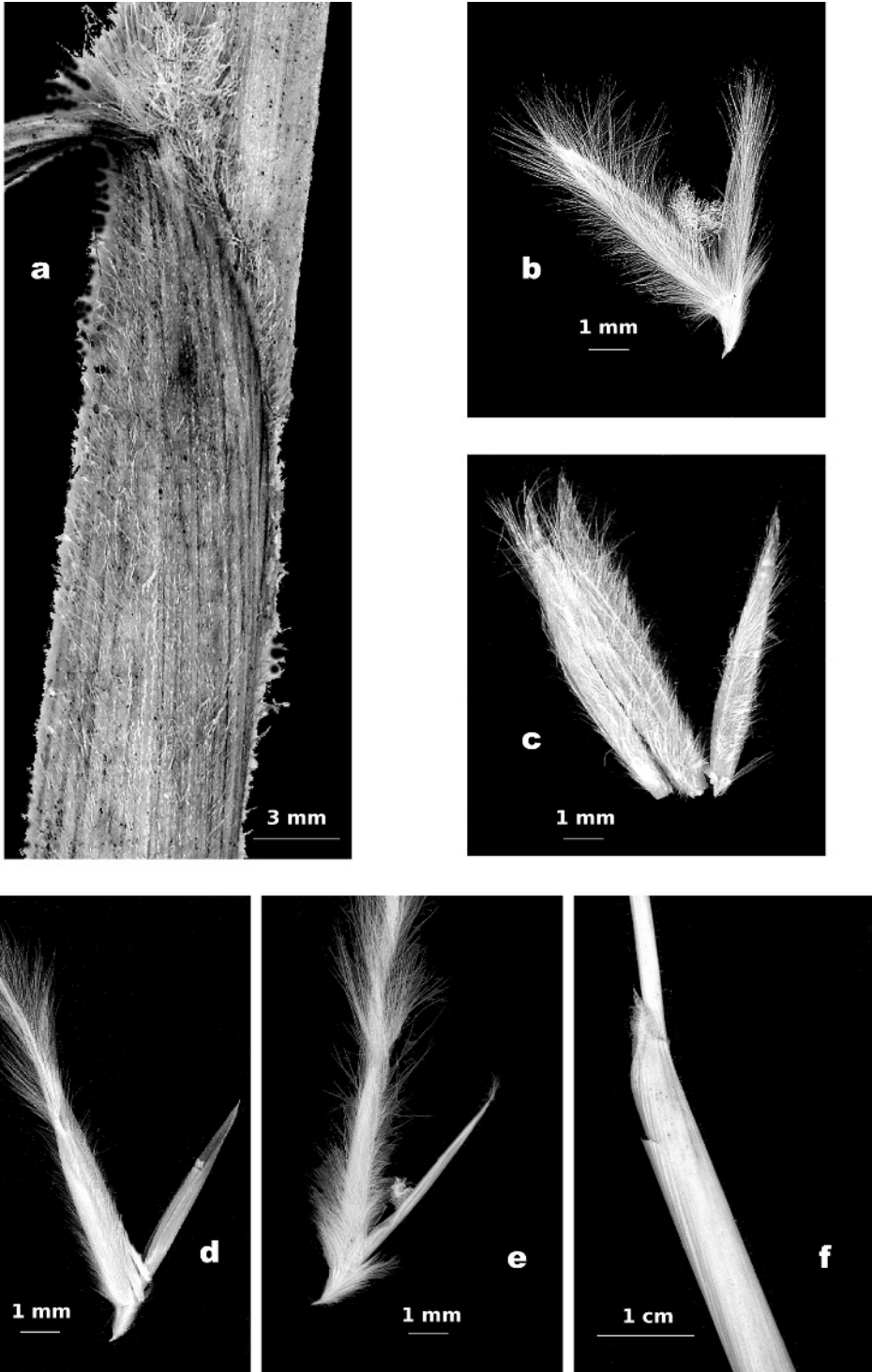


Figure 1. —a. *Stipa antiatlantica*. Pubescence on the upper third of the leaf sheaths. —b. *S. antiatlantica*. Pubescent back of the lemma and pubescent palea with long trichomes. —c. *S. tenacissima* subsp. *gabesensis*. Pubescent back of the lemma and pubescent palea with scattered trichomes. —d. *S. tenacissima* subsp. *tenacissima*. Pubescent back of the lemma, palea glabrous. —e. *S. tenacissima* subsp. *tenacissima*. Pubescent back of the lemma, palea glabrous with some trichomes near the apex. —f. *S. tenacissima* subsp. *tenacissima*. Upper part of the glabrous leaf sheath.

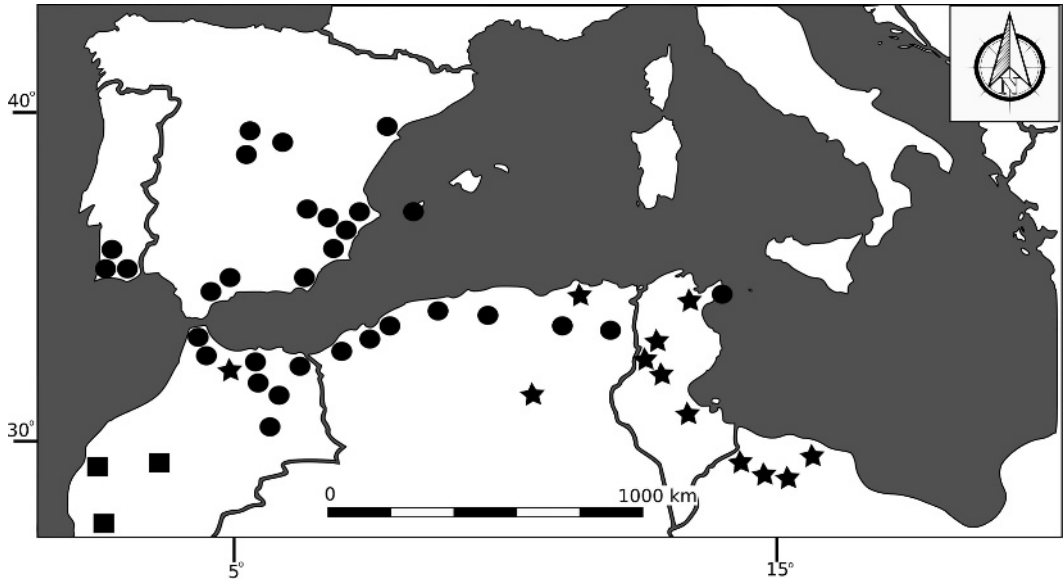


Figure 2. Distribution map. *Stipa antiatlantica* (■). *S. tenacissima* subsp. *tenacissima* (●). *S. tenacissima* subsp. *gabesensis* (★).

Chromosome number. The base chromosome number of *Stipa* L. subgen. *Macrochloa* is $x = 6$ (Abdelkrim & Bensettiti, 1988) [unlikely] or $x = 12$ (Vázquez & Devesa, 1996), 10, or 11. In the hexaploid case, the basic chromosome number of *Stipa tenacissima* subsp. *gabesensis* is 12, thus similar to that of the typical subspecies, but differing from the basic chromosome number of 11 for *S. antiatlantica*, and 10 for Portuguese (Algarve) individuals of *S. tenacissima*. The chromosome base numbers for genus *Stipa* are $x = 9, 10, 11,$ or 12 (Hilu, 2004; Watson & Dallwitz, 2003), with sporophytic counts = 22 [putative diploids] [*S. lagascae* Roemer & Schultes, Devesa et al. 1991, *S. sibirica* (L.) Lamarck, Stepanov, 1994], 24 [*S. bromoides* (L.) Döerfler, Strid & Andersson, 1985], 28 [*S. parviflora* Desfontaines, Vázquez & Devesa, 1996], 36 [putative triploids] [*S. capensis* Thunberg, Vázquez & Devesa, 1996], 40 [putative tetraploids] [*S. coronata* Thunberg, Reeder, 1984], or 44 [*S. barbata* Desfontaines, Vázquez & Devesa, 1996] (with 44 most often), 66 [putative hexaploids] [*S. epilosa* Martinovsky, Kozuharov & Petrova, 1991] and 96 [putative octoploids] [*S. gigantea* Link, Vázquez & Devesa, 1996]; the chromosomes are small to medium sized; nucleoli are reported to disappear before metaphase (Hilu, 2004; Watson & Dallwitz, 2003). The chromosomal diversity in *Stipa* represents speciation enhanced by various levels of euploidy and aneuploidy (Hilu, 2004).

Micromorphology. Leaf blade with distinct, prominent adaxial ribs, with the ribs very irregular in size. Midrib not readily distinguishable, with one bundle only, without colorless mesophyll adaxially. Mesophyll with non-radiate chlorenchyma, without adaxial palisade. The lamina symmetrical on either side of the midrib. All the vascular bundles accompanied by sclerenchyma. Sclerenchyma not all bundle-associated. Additional sclerenchyma in a continuous abaxial layer, joining the bundles. A single pair of subsidiary bundles present below the secondary bundles in *Stipa tenacissima* subsp. *gabesensis* from Libya and Tunisia, with two pairs in *S. tenacissima* subsp. *tenacissima* from Spain. Outer sheath cells usually smaller than chlorenchyma cells, their walls much thickened. Inner sheath composed of small cells with conspicuously thickened walls.

Esparto fibers have thick walls and are short, normally less than 3 mm in length, with an average length of 1.5 mm. The fiber diameter varies from about 5–15 μm , with an average of about 12 μm . The fibers also tend to be curved and twisted.

Most of Steudel's infrageneric taxa and all in *Stipa* are unranked, but these were assigned sectional rank by Pfeiffer (1873–1874). Due presumably to the difficult interpretation of Steudel's and Pfeiffer's infrageneric ranks, Vázquez and Devesa (1996: 21) invalidly combined *Macrochloa* as section of *Stipa* (nom. superfl.).

KEY TO THE SPECIES AND SUBSPECIES OF ESPARTO GRASS (*STIPA* SUBG. *MACROCHLOA*)

- 1a. Sheaths glabrous or, rarely, having a slightly harsh surface in the upper third (scabrous); paleas glabrous or pubescent throughout 2
 2a. Paleas glabrous or with a dorsal line of trichomes; awns 47–57(–88) mm *Stipa tenacissima* subsp. *tenacissima*
 2b. Paleas pubescent throughout; awns (45–) 58–73(–88) mm. *Stipa tenacissima* subsp. *gabesensis*
 1b. Sheaths distally pubescent; paleas pubescent throughout *Stipa antiatlantica*

1. *Stipa tenacissima* Loeffling ex L., Cent. Pl. I: 6. 1755. *Macrochloa tenacissima* (Loeffling ex L.) Kunth, Revis. Gram. 1: 58. 1829. *Lasiagrostis tenacissima* (Loeffling ex L.) Trinius & Ruprecht, Spec. Gram. Stirp. 1: 94. 1842. TYPE: [Spain] “Habitat in Hispaniae collibus sabulosis” and “Bauh. Pin.5...Clusii hist. 2 p. 220” *Loeffling s.n.* (lectotype, designated by Vázquez et al., Anal. Jard. Bot. Madrid 52 (2): 184–185, 1995; LINN 94.7).

1a. *Stipa tenacissima* subsp. *tenacissima*.

Stipa kelibiae Moraldo, Raffaelli & Ricceri, Candollea 44: 80. 1989. TYPE: [Tunisia] “betw. Kelibia & El-Haouaria, 30 m., 13 Apr. 1986,” *M. Raffaelli & C. Ricceri, s.n.* (holotype, FI 3016/2 not seen; isotype, FI).

Leaf sheaths glabrous (Fig. 1f) or, rarely, having a slightly harsh surface in the upper third (scabrous); ligule replaced by a pair of trichome tufts, basal leaves 2–4 cm long, upper leaves 1–2 cm long. Leaf blade linear, narrow, strict, convolute, abaxially glabrous and adaxially pubescent, (0.6)1.3–1.5(2.0) mm wide. Inflorescence contracted, paniculate, lanceolate or spindle shaped, 30–40 cm long, not deciduous, with 15 to 30 branchlets and 40 to 80 spikelets, spatheate. Glumes 2, subequal; upper glume (18)21–25(31) mm, lower glume (21)24–30(39) mm, glabrous, entire, with pubescent veins; lemmas lanceolate, (7.0)9.2–10.3(13.2) mm, lobes (1.0)1.6–2.2(3.5) mm, pubescent; lemma awns 1, (36)47–57(88) mm; palea (7.0)8.5–9.0(12.7) mm, glabrous (Fig. 1d), or partially pubescent at the apex (Fig. 1e), or sparsely pubescent adaxially.

Illustration. Tab. 30 in Desfontaines (1798); figure 3 in Raffaelli and Ricceri, 1989: 81.

Chromosome number. [Sporophytic ?] 12 (Abdelkrim & Bensettiti, 1988, Algeria), [sporophytic] 24 (Labadie, 1979, Algeria), [sporophytic] 40 (Fernandes & Queiros, 1969, Portugal).

Distribution, ecology, and phytogeography. Iberian Peninsula and northern Africa, north of Morocco and

Algeria. 10–800 m, reaching 1900 m in Morocco. Esparto grass lands and heaths in well-drained carbonate soils (calcareous, dolomites, margo-calcareous soils, loams and gypsiferous loams). Bioclimatic belts: arid infra-Mediterranean, semi-arid thermo-Mediterranean, dry thermo-Mediterranean, semi-arid meso-Mediterranean, and dry meso-Mediterranean (sensu Rivas-Martínez et al., 1999).

Selected specimens examined. **EUROPE.** **SPAIN.** **Albaete:** Bonete, Cerro Chinar, *Rivera s.n.* (MAF-134116). **Alicante:** Beniardá, Peña Martí, *Solanas s.n.* (ABH-4872); Pinoso, *Camuñas s.n.* (ABH-6709); Onil, El Biscoig, *Calabuig s.n.* (ABH-7134); Villena, Cabezo de Jordán, *Alonso s.n.* (ABH-8346); S^a del Maigmo, *De la Torre s.n.* (MUB-14512); Altea, Sierra de Bernia, *Soler et al. s.n.* (ABH-158151); Benissa, *Barber s.n.* (ABH-9679); Crevillente, La Garganta, *Vicedo s.n.* (ABH-8364); Petrer, *Juan & Cristóbal s.n.* (ABH-10022); Alicante, Castillo de Santa Bárbara, *Camuñas & Crespo s.n.* (ABH-32188); Orihuela, Dehesa de Campoamor, *Espinas et al. s.n.* (ABH-17502); Monóvar, Sierra del Reclot, *Navarro et al. s.n.* (ABH-36639). **Almería:** San José, Cabo de Gata, *Codina s.n.* (ABH-11762); Fernán Pérez, Cerro Jayón, *Sanz Fábregas s.n.* (MAF-141621); Velez Rubio, *García Gea s.n.* (MUB-19507). **Balearic Islands:** Ibiza, Canal Rosari to Cala Londal, *Font Quer s.n.* (MA-5223); Ibiza, Cap Martinet, *Rivas Martínez, Costa & Regueiro s.n.* (MA-422483); Espartal island, near Ibiza, *F. Palau s.n.* (MA-158280). **Córdoba:** near Priego, *Borja s.n.* (MAF-71164); Priego, *Borja s.n.* (MAF-102574). **Guadalajara:** Loranca de Tajuña, *F. Bellot, Carballal & Ron s.n.* (MA-198084); Hontova, *F. Bellot, Carballal & Ron s.n.* (MA-198085). **Madrid:** Aranjuez, close to Ontígola pool, *Valle, Ruiz & González s.n.* (MAF-117817); Villamanrique de Tajo, *D. Belmonte s.n.* (MAF-119881); Campo Real, *D. Belmonte s.n.* (MAF-120048); Torrelaguna, *A. Galán de Mera s.n.* (MAF-120384). **Málaga:** Sierra de Yeguas, Sierra de los Caballos, *Talavera & Valdés 2054/73* (MAF). **Murcia:** Aguilas, Sierra de la Fuente del Pobre, *Fernández s.n.* (MAF-93813); El Carmolí, *Alcaraz s.n.* (MUB-3480); S^a del Molino, Calasparra, *Fdez./Fdez.-Delgado s.n.* (MUB-3915); Bco. del Pozo, S^a de Ricote, *Olmo & Hurtado s.n.* (MUB-4999); S^a del Baño, Fortuna, *Alcaraz s.n.* (MUB-7214); S^a del Cantón, Abanilla, *Alcaraz s.n.* (MUB-7789); Sierra de Abanilla, Abanilla, *Alcaraz s.n.* (MUB-7844). **Tarragona:** Pons. Ametllá de Mar, *Raynal 18820* (MAF-105008). **Toledo:** Ocaña, Arroyo del Corralejo valley, *Águila, Laorga & Sánchez-Mata s.n.* (MAF-107321); Mora, “Quemadillo,” Algodor river hills, *S. Laorga s.n.* (MAF-110886). **PORTUGAL.** **Algarve:** Albufeira, Barrocal da Gralheira, *E. Paunero 6048* (MA); Barrocal da Gralheira, *Malato-Beliz et al. 6048* (MA); Loulé, road to Sao Brás de Alportel, road to Ribeira das Mercês, *Malato-Beliz & J. A. Guerra 15318* (MA); tableland betw. Sagres & S Vicente, *Paunero 5817* (MA), *Malato-Beliz & Guerra 5817* (MA); Loulé, road to Barranco do Velho, Olho de Agua top, Cabeça Gorda, *Malato-Beliz & Guerra 15186* (MA); between Lagos & Vila do Bispo, Luz beach, *Malato-Beliz 3167* (MA); Monte Clérigo beach, *Segura Zubizarreta s.n.* (MA-957356); Monte Clérigo, *J. Nogueira 10317* (COI); Loulé road to Barranco do Velho, Olho de Agua top, Cabeça Gorda, *Malato-Beliz & Guerra 15186* (MA); hill above Cabeça Gorda of Loulé, *Malato-Beliz & Guerra 15651* (MA); Cerro da Zorra, *Malato-Beliz & Guerra 15771* (MA); Cape S Vicente, *J. F. Guimaraes s.n.* (COI); Budens, *Fernandes et al. 7348* (COI); Tavira, *J. F.*

Guimaraes s.n. (COI). **AFRICA. ALGERIA. Orán:** Orán, Djebel Santo plain, *O. Debeaux s.n.* (G-8473/5); Djebel Santo, *J. A. Battandier & L. Trabut s.n.* (G-8473/6), *E. Bourgeau s.n.* (G-8473/12); Mers el Kebir, *Pitard s.n.* (G-8473/24); Santa Cruz, *H. Romieux 1086* (G [2]); Arzew, *Bové s.n.* (G-8473/15 & G-8473/33); Country of Orán, *G. L. Durando 184* (G [3]); Aïn-el-Turk plain, near Orán, *B. Balansa 286* (G [3]); Tlemcen, *Havard s.n.* (G-8473/25); Pointe Canastel, 15 km E Orán, *D. A. & S. J. Sutton 280* (RNG). **Algiers:** Wilaya M'Sila, Saharian Atlas, 27 km SW Bou Saada on the road to Djelfa, *D. Podlech 37196* (G); Teniet-El-Had, *D. L. Trabut s.n.* (MA-5228); 10 km SW Djelfa, *Davis 53315* (RNG). **Constantine:** Batna, Constantine south, *Thiebault 1887* (G [2]); Aïn Beida, *Girod s.n.* (G-8473/20). **MOROCCO. Rif:** Near Xauen, *Font Quer 22* (G & MA); Ech Chaoun, *M. Gandoger s.n.* (G-8473/13); Tetuan, Djebel Dersa, *C. J. Pitard 441* (G [2]); Tetuan, Bab Taza, hill before Adeldal, way to Tarifa, *M. A. Mateos & J. M. Montserrat JMM5528/3* (RNG); Al-Hoceima, El-Yebha, *J. M. Montserrat & B. Valdés, 2953/94* (RNG); Kert Ganc, 80 km SW Nador, 4 km from Ain Zorah on the road from Saka, *A. Achal et al. OPTIMA V/875* (RNG). **High Atlas:** 111 km N from Errachidia (Ksars-es-Souk) along road P21 to Midelt, a few km south of Tizi-n-Tairhemt, *Jury, Rejdali & F. Watson 9238* (MA & RNG). **Orient Tableland:** Oujda, Beni Snassen mountains, after Taforal, *Eilafski, Mateos & Valdés BV593/93* (RNG); Deboud, Oujda, *Wilczek et al. 479* (G). **TUNISIA. Kelibia:** Between Kelibia and El-Haouaria, *Raffaelli & Ricceri s.n.* (FI).

1b. *Stipa tenacissima* subsp. *gabesensis* (Moraldo, Raffaelli & Ricceri) Barreña, D. Rivera, Alcaraz & Obón, comb. et stat. nov. Basionym: *Stipa gabesensis* Moraldo, Raffaelli & Ricceri, *Candollea* 44: 78. 1989. TYPE: [Tunisia] "Pseudosteppe aux environs de Gabès, 16 Apr. 1986." *Raffaelli & C. Ricceri s.n.* (holotype, FI 3016/1 not seen; isotype, FI).

Stipa kralifii Moraldo, Raffaelli & Ricceri, *Candollea* 44: 80. 1989. Syn. nov. TYPE: [Tunisia] "Route n. 13 entre Sfax et Faïd, pentes du Djebel Sidi Kralif, 300–350 m, 16 Apr. 1986." *M. Raffaelli & C. Ricceri s.n.* (holotype, FI 3016/3 not seen; isotype, FI).

Sheaths glabrous or scabrous; ligule replaced by a pair of trichome tufts, 2–4 cm long on the basal leaves, 1–2 cm long on the upper leaves. Leaf blade linear, narrow, frequently strict, convolute, abaxially glabrous and adaxially pubescent, (0.4)1.3–1.5(2.4) mm wide. Inflorescence contracted, paniculate, broadly lanceolate, 30–40 cm long, not deciduous, with 10 to 25 branchlets and 30 to 60 spikelets, spatheate, spikelet-bearing axes persistent, pubescent, with 1 to 7 spikelets each. Glumes 2, ± equal, upper glume (19)23–26(30) mm, lower glume (20–)25–29(-33) mm, glabrous, entire to 2-cleft (in its upper part), with pubescent veins; lemmas lanceolate, (7.4)8.8–9.8(12.4) mm, lobes (0.8)1.6–2.2(3.0) mm;

awns 10(45)–58–73(88) mm; palea (6.4)7.5–8.3(10) mm, pubescent throughout (Fig. 1c).

Chromosome number. [Gametophytic] 36, Libya, putative hexaploid (Faruqi et al., 1987).

Illustrations. Figures 2, 4 in Raffaelli and Ricceri (1989: 79, 82).

Distribution, ecology, and phytogeography. Central Tunisia, eastern Algeria from the Ouled-Djellal zone, and western Libya from Tripolitania, 450–710 m (Fig. 2). One sheet (*Martin & Paunero s.n.* (MA-29162)) containing plants from Benisicar, Morocco, shows characteristics similar to this subspecies. Esparto grass lands and scrubs on carbonate soils. Bioclimatic belt: thermo-Mediterranean semiarid (Rivas-Martínez et al., 1999).

Stipa kralifii is referred to *S. gabesensis* for the first time. However, both were referred to *Stipa tenacissima* by Vázquez and Devesa (1996).

Selected specimens examined. **AFRICA. ALGERIA. Constantine:** Zab mtns., near Ouled-Djellal crossroads, *Robledo & Sanchez s.n.* (MUB-18953); El Kantara, *Chevallier* (FI). **LIBYA. Tripoli:** Djebel Nafusah, 17 km from Jadu to Efrén, *Davis 49705* (RNG); 23 km W Khoms, Djebel Nafusah, *Davis 49797* (RNG); Sine loc., *Onofry s.n.*, (RO); Jadu [Tripoli district], *E. Carano & G. Lusina s.n.* (RO [2]); Kasr Daun, *Pampanini, 2348* (FI); Tarhuna, Uadi Msaaba, *Pampanini 1408* (FI); Plateau betw. Misdá & Gharian, *Bargagli-Petruci s.n.* (FI); Gharian, Uadi Gharian, *Pampanini 3908* (FI); Ras Bu Taulil, *Pampanini 1340* (FI); Abiar Milgah in Ras Ter, *Pampanini 1138* (FI); Abiar Milgah in Ras Neb, *Pampanini 475* (FI); Mesellata, *Pampanini 3152* (FI); Nalut tableland, *Comtesse O. Bargagli-Petruci s.n.* (FI); between Nalut and Sinauen, *Comtesse O. Bargagli-Petruci s.n.* (FI). **MOROCCO. Rif:** Benisicar, *Martin & Paunero s.n.* (MA-29162). **TUNISIA. Kairouan:** Bou-Kournim, *Cuénod s.n.* (G-8473/14), *Cuénod s.n.* (G-8473/14); 22 km S of Kasserina, *Kennedy s.n.* (RNG). **Gabès:** Djebel-Gafsa, *Pitard 5227* (MA); near 52 km NW Gafsa tow. Feriana, *Davis & Lamond D57343* (RNG); road Metameur–Matmata, *Raffaelli & Ricceri s.n.* (FI).

2. *Stipa antiatlantica* Barreña, D. Rivera, Alcaraz & Obón, sp. nov. TYPE: [Morocco] "Agadir. Tizi Mlil, near Tafraoute (Anti Atlas) 29°43'N, 8°51'W, unploughed grounds on volcanic substrata, 1800 m, 5 Jun. 1980," *A. Charpin, J. Fernández-Casas, F. Jacquemoud & D. Jeanmonod MAR-275* (holotype, G 179625; isotype, MA-292529).

Stipa tenacissima var. *villosiuscula* Lindberg, *Itin. Mediterr.*: 24. 1932. TYPE: [Morocco] "Atlas major in monte Djebel Amsitten, in rupe in valle supra Tis Rarin. In convalle fluminis Iminin, in declivibus saxosis montis Djebel Tihalatine, c. 1500 m," *H. Lindberg* (holotype, H not seen).

Paleis numquam glabris atque dense pubescentibus et vaginis foliorum apice pubescenti a *Stipa tenacissima* subspecie *gabesensi* et typica differt.

Leaf sheaths pubescent, especially in the upper third (Fig. 1a); ligule replaced by a pair of trichome tufts, 2–4 cm long on the basal leaves, up to 1 cm long on the upper leaves. Leaf blade linear, narrow, convolute, abaxially glabrous and adaxially pubescent, 1.1–1.5(1.7) mm wide. Inflorescence contracted, paniculate, broadly lanceolate, 30–40 cm long, not deciduous, with 10 to 30 branchlets and 30 to 80 spikelets, spatheate, spikelet-bearing axes persistent, pubescent, with 1 to 7 spikelets each. Glumes 2, \pm equal; upper glume (21)22–26(30) mm and lower glume (23)25–29(32) mm, glabrous, entire, with pubescent veins, lemmas, (8)8.7–9.2(10.0) mm, lobes (1)1.8–2.4(2.9) mm, awns 10(47)55–59(61) cm, palea (7.5)8.2–9.0(9.5) mm, pubescent throughout (Fig. 1b).

Chromosome number. [Sporophytic] [= 6x?] = 66, putative hexaploid, Morocco (Lungeanu, 1980).

Distribution, ecology, and phytogeography. Africa, from southern Morocco, the province of Agadir (Fig. 2); 1250–1800 m; from esparto grass lands and scrubs in calcareous soils. Bioclimatic belts: thermo-Mediterranean semiarid (Rivas-Martínez et al., 1999), within the *Acacion gummiferae* Barbero, Quézel & Rivas-Martínez group of plant communities, especially *Polygalo balansae*–*Arganietum spinosae* Barbero, Benabid, Quézel, Rivas-Martínez & Santos (Barbero et al., 1982). Maquis shrubland of *Tetraclinis articulata* (Vahl) Masters and *Cistus* spp. on sandy soil.

Neither of the two specimens cited by Harald Lindberg in the protologue of *Stipa tenacissima* var. *villosiuscula* Lindberg could be found in the Herbarium, Botanical Museum, University of Helsinki (H). In fact, there seems to be no material labeled as *S. tenacissima* var. *villosiuscula* in H. Moreover, *S. tenacissima* var. *villosiuscula* is not included in the catalogue of type specimens in H, and there is no reference to the specimens mentioned above. Strangely, these two specimens seem to be the only Lindberg specimens of *Stipa* that are missing in the H collections. The other 24 collections mentioned on the same page (Lindberg, 1932: 24) with *S. tenacissima* var. *villosiuscula*, for *S. arenaria* Brotero, *S. aristella* L., *S. barbata* Desfontaines, *S. gigantea* Lagasca, *S. lagascae* Roemer & Schultes, *S. nitens* Ball, *S. parviflora* Desfontaines, *S. tenacissima* L., and *S. tortilis* L., were all located by J. Nurmi (pers. comm.).

Selected specimens examined. **AFRICA.** MOROCCO. **Anti-Atlas:** Tizi Mlil near Ttrafaute (Anti-Atlas), *Charpin, Fdez. Casas, Jacquemoud & Jeanmonod MAR 275* (G, MA). **High Atlas:** High Atlas, 20 km NE on road P 32 near Tizi-n-Test, *Podlech 42788* (G). **Essaouira:** above Essaouira [Mogador], *P. & J. Davis s.n.* (BM 756976).

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APPENDIX 1

LIST OF SPECIES

1. *Stipa tenacissima* Loeffling ex L.
 - 1a. *Stipa tenacissima* L. subsp. *tenacissima*
 - 1b. *Stipa tenacissima* L. subsp. *gabesensis* (Moraldo, Raffaelli & Ricceri) Barreña, D. Rivera, Alcaraz & Obón.
2. *Stipa antiatlantica* Barreña, D. Rivera, Alcaraz & Obón

APPENDIX 2

INDEX TO EXSICCATAE

Specimens examined are listed alphabetically by collector, followed by collection numbers and herbarium (herbarium numbers are given for specimens with no collection numbers). The species number corresponds to its number in the List of Species.

Acchal et al. (RNG) (1a); *Águila, Laorga & Sánchez-Mata* (MAF) (1a); *Alcaraz* (MUB-6946, MUB-6947, MUB-7214, MUB-7789, MUB-7844, MUB-7846, MUB-30511a, MUB-3480, MUB-6939) (1a); *Alonso* (ABH-8346) (1a); *Anonymous* (MUB-11449) (1a).

Balansa (G-8473/17, G-8473/34, G-8473/36) (1a); *Barber* (ABH-9679) (1a); *Bargagli-Petruci* (FI) (1b); *Battandier & Trabut* (G-8473/6) (1a); *Belmonte* (MAF-119881, MAF-120048) (1a); *Bellot, Carvallal & Ron* (MA-198084, MA-198085) (1a); *Borja* (MAF-102574, MAF-71164) (1a); *Bourgeau* (G-8473/12) (1a); *Bové* (G-8473/15, G-8473/33) (1a).

Calabuig (ABH-7134) (1a); *Campos* (MUB-2945); *Camuñas & Crespo* (ABH-32188) (1a); *Camuñas* (ABH-6709) (1a); *Carano & Lusina* (RO-2) (1b); *Codina* (ABH-11762) (1a); *Cuénod* (G-8473/14) (1b), (G) (1b); *Charpin, Fdez. Casas, Jacquemoud & Jeanmonod* (G-179625, MA-292529) (2); *Chevallier* (FI) (1b).

Davis D49705 (RNG) (1b); *Davis D49797* (RNG) (1b); *Davis & Davis* (BM 756976) (2); *Davis & Lamond D57343* (RNG) (1b); *De la Torre* (MUB-14512) (1a); *Debeaux* (G-8473/5) (1a); *Durando* (G-8473/16, G-8473/27, G-8473/35) (1a).

Espinar et al. (ABH-17502) (1a); *Etlafski, Mateos & Valdés BV593/93* (RNG) (1a).

Fdez./Fdez.-Delgado (MUB-3915); *Fernández* (MAF-93813) (1a); *Font Quer* (G-8473/10, MA-5223, MA-5230) (1a).

Galán de Mera (MAF-120384); *Gandoger* (G-8473/13, G-8473/40, G-8473/41) (1a); *García Gea* (MUB-19507) (1a); *Girod* (G-8473/20) (1a); *Guirao* (MUB-3053) (1a).

Havard (G-8473/25) (1a).

Izco (MAF-73689) (1a).

Jimenez (MUB-39557) (1a); *Juan & Cristóbal* (ABH-10022) (1a); *Jury, Rejdali & Watson 9238* (MA, RNG) (1a).

Kennedy (RNG) (1b).

Laorga (MAF-110886) (1a).

Malato-Beliz (MA-291076, MA-484180) (1a); *Malato-Beliz & Guerra* (MA-232782, MA-291079, MA-291081, MA-291082) (1a); *Malato-Beliz et al.* (MA-291077) (1a); *Malato-Beliz & J. A. Guerra* (MA-291080) (1a); *Martin & Paunero* (MA-29162) (1b); *Mateos & Montserrat JMM5528/3* (RNG) (1a); *Miñarro & Periago* (MUB-4442) (1a); *Montserrat & Valdés, 2953/94* (RNG) (1a).

Navarro & Sánchez-Mata, 78 (MAF-111415) (1a); *Navarro, Navarro & Mondejar* (ABH-36639) (1a).

Olmo (MUB-13636) (1a); *Olmo & Hurtado* (MUB-4999); *Onofry* (RO) (1b).

Palau (MA-158280) (1a); *Pampanini 1138* (FI); *Pampanini 1340* (FI) (1b); *Pampanini 2055* (FI) (1b); *Pampanini 2055* (FI) (1b); *Pampanini 2575* (FI) (1b); *Pampanini 2676* (FI) (1b); *Pampanini 3268* (FI) (1b); *Pampanini 3410* (FI) (1b); *Pampanini 3647* (FI) (1b); *Pampanini 575* (FI) (1b); *Pampanini 2348* (FI) (1b); *Pampanini 475* (FI) (1b); *Pau* (MA-5229) (1a); *Paunero* (MA-187951, MA-187950) (1a); *Pineda, Salinas & Ruiz* (MUB-36261) (1a); *Pitard* (G-8473/21, G-8473/26, G-8473/24) (1a); *Pitard* (MA) (1b); *Podlech* (G-284110) (1a); *Podlech* (G-360086) (2).

Raffaelli & Ricceri (FI) (1a); *Raffaelli & Ricceri* (FI) (1b); *Raynal 18820* (MAF-105008); *Rivas Martínez, Costa & Regueiro* (MA-422483) (1a); *Rivera* (MAF-134116) (1a); *Robledo & Sanchez* (MUB) (1b); *Robledo* (MUB-15838) (1a); *Rodriguez* (MUB-12110) (1a); *Romieux* (G-8473/19) (1a).

Sánchez-Mata & Navarro (MAF-134954) (1a); *Sanz Fábregas* (MAF-141621) (1a); *Segura Zubizarreta* (MA-957356) (1a); *Selma* (MUB-19255) (1a); *Solanas* (ABH-4872) (1a); *Soler & Soler* (ABH-16759) (1a); *Soler, Martínez & Soler* (ABH-15851) (1a); *D. A. & S. J. Sutton 280* (RNG) (1a).

Talavera & Valdés (MAF-125100) (1a); *Thiébault* (G-8473/8, G-8473/29) (1a); *Trabut* (MA-5228) (1a).

Valle, Ruiz & González (MAF-117817) (1a); *Vicedo* (ABH-8364) (1a).