Plant Syst Evol (2008) 276:177–189
DOI 10.1007/s00606-008-0076-1

ORIGINAL ARTICLE

Morphometric analysis of *Schizachyrium condensatum* (Poaceae) and related species

Myriam Carolina Peichoto · Silvia Matilde Mazza · Viviana Griselda Solís Neffa

Received: 14 March 2008 / Accepted: 21 July 2008 / Published online: 27 September 2008

Abstract Our aim was to assess the degree of morphological differentiation of a group of taxa of *Schizachyrium* Nees, which presents similar inflorescences and shares habitat and geographic areas: *Schizachyrium bimucronatum*, *S. condensatum*, *S. lactiflorum*, *S. microstachyum* subsp. *microstachyum*, *S. microstachyum* subsp. *elongatum*, and *S. plumigerum*. To accomplish this purpose, 22 exomorphological traits were analyzed using multivariate methods. The results obtained support the identity of *Schizachyrium condensatum* and related species as independent taxa. In addition, the analysis evidences the reliability of several inflorescence characters, which had not been previously considered in the identification of the different taxa. Based upon the information obtained, a new identification key for these taxa was constructed.

Keywords Gramineae · Andropogoneae · *Schizachyrium* · Morphological variation · Multivariate analysis · Taxonomy · South America

Introduction

The genus *Schizachyrium* Nees belongs to the tribe Andropogoneae Dumort. This genus is widely distributed in tropical and subtropical regions of Africa, America, Asia, and Australia (Chippindall 1955; Clayton 1972a, b; Nicora and Rúgolo de Agrasar 1987; Gibbs Russell et al. 1990; Watson and Dallwitz 1992; Clayton et al. 2002). According to Clayton and Renvoize (1986), *Schizachyrium* comprises about 60 species. In America, 30 species are found, 16 of them being important components of South American grasslands and savannas, ranging from Colombia to Chile, Argentina, and Uruguay (Filgueiras 2003; Peichoto 2006).

Seventeen species are currently recognized for South America, and are concentrated in southern Brazil and Paraguay, north-eastern Argentina and Uruguay. These taxa were divided in two groups on the basis of exomorphological studies. One of them contains taxa with highly branched feathery inflorescences and slender rachis internodes, while the other group is characterized by sparsely branched inflorescences and thick rachis internodes. Within the first group are included *S. bimucronatum* Roseng., B.R. Arrill. & Izag., *S. condensatum* (Kunth) Nees, *S. lactiflorum* (Hack.) Herter, *S. microstachyum* (Desv. ex Ham.) Roseng., B.R. Arrill. & Izag. subsp. *microstachyum*, *S. microstachyum* subsp. *elongatum* (Hack.) Roseng., B.R. Arrill. & Izag., and *S. plumigerum* (Ekman) Parodi. Besides their morphological affinities, these species and subspecies also share geographic areas and habitat requirements (Peichoto 2007).

The taxonomy of this group of species has been controversial with different treatments by diverse authors. Rosengurtt et al. (1968) firstly differentiated these taxa on the basis of inflorescence characters and referred them as "related to *Schizachyrium condensatum*," since this name is the oldest among all the taxa involved. However, the same authors recognize that some traits employed in the key are not easy to use in species identification, since they are hardly perceptible, overlapping to some extent or with similar variation ranges in the dichotomy. In the revision of the genus for South America, Türpe (1984) included *S. bimucronatum*, *S. lactiflorum*, *S. microstachyum* subsp. *microstachyum*, *S. microstachyum* subsp. *elongatum*, and

M. C. Peichoto (✉) · V. G. S. Neffa
Instituto de Botánica del Nordeste, Corrientes, Argentina
e-mail: mcpeichoto@agr.unne.edu.ar

S. M. Mazza
Facultad Ciencias Agrarias, UNNE, Corrientes, Argentina

S. plumigerum under *S. condensatum*, on the basis of the analysis of only five traits. After this review, some authors accepted *S. condensatum* in a broad sense (Renvoize 1984, 1988, 1998; Zanin 2001), while others acknowledged *S. microstachyum* and *S. condensatum* as different species (Killeen 1990; Tovar 1993; Pohl 1994; Filgueiras 2003).

Recently, a comparative study of the sinflorescences of *S. condensatum* and related species contributed to the interpretation of their complex system of ramification. Moreover, this study proved that several characters of the inflorescence, which had not been considered by Rosengurtt et al. (1968), varied among the species and, therefore, would be useful in the identification of these taxa (Peichoto and Vegetti 2007).

On this basis, the aim of this paper is to assess the morphological variation of *S. condensatum* and related species to clarify their taxonomic validity.

Materials and methods

The material studied is listed in Appendix. Four qualitative and eighteen quantitative morphological traits (Table 1, Fig. 1) were measured on 294 herbarium specimens from the following herbaria: BAA, BAB, CTES, ESA, G, ICN, K, LPB, MO, NY, P, QCA, SI, and W. The herbaria consulted were cited according to Holmgren et al. (1990). These specimens were selected to cover the geographic range and the morphological variability of each species.

Vegetative traits (stem height, ligule, and leaf) were measured on fertile innovations. For each specimen, the mean of the blade length and width was obtained from measurements of three leaves of the middle portion of the stem. The reproductive organ traits (inflorescence, peduncle, spatheole, and spiciform raceme), when possible, were measured in complete mature racemes. The inflorescences were classified according to Peichoto and Vegetti (2007). The analysis of the spikelet features was conducted in the middle portion of the spiciform raceme.

Quantitative variables were transformed by the Escoffier's method (Escoffier 1979). This method was chosen, since, contrarily to the transformation in multistate quantitative variables, it does not involve loss of information. The method consists in transforming each quantitative variable in two new variables: $x- = (1 - x_i)/2$ and $x+ = (1 + x_i)/2$, where x_i is the value of the standard variable for i individuals. The discrete variables were dichotomized taking into account the upper and lower values to the medium one.

The distribution of each variable in the different groups was analyzed using diagrams boxes. The mean average, standard deviation, and range of variation were calculated for each variable. To evaluate the existence of significant differences for each trait among the taxa analyzed, one-way ANOVA at a significance level of 5% ($\alpha = 0.05$) after

Table 1 Morphological traits used and their codes or units

Character (abbreviation for the graphics)	Codes/Units
1. Stem height (SH)	cm
2. Blade length (BL)	mm
3. Blade width (BW)	mm
4. Ligule length (LL)	mm
5. Inflorescence length (IL)	cm
6. Inflorescence shape (IS)	1: panicle-like, 2: corymb-like
7. Inflorescence internodes number (IIN)	
8. Spatheole length (SL)	mm
9. Shape of the upper portion of the spatheole (SS)	1: strongly convolute, 2: subconvolute to fully open
10. Peduncle length (PL)	mm
11. Peduncle degree of exsertion (PE)	1: included, 2: upper portion exserted.
12. Raceme length (RL)	mm
13. Rachis internodes number (RIN)	
14. Rachis internodes length (RIL)	mm
15. SS: lower glume length (SS GI)	mm
16. SS: lower glume apex (SS GIA)	1: acute or subacute, 2: unequally bimucronate
17. SS: upper glume length (SS GII)	mm
18. SS: awn length (SS A)	mm
19. PS: glume length (PS G)	mm
20. PS: pedicel length (PS P)	mm
21. PS: awn length (PS A)	mm
22. Caryopsis length (CL)	mm

SS sessile spikelet, *PS* pedicellate spikelet

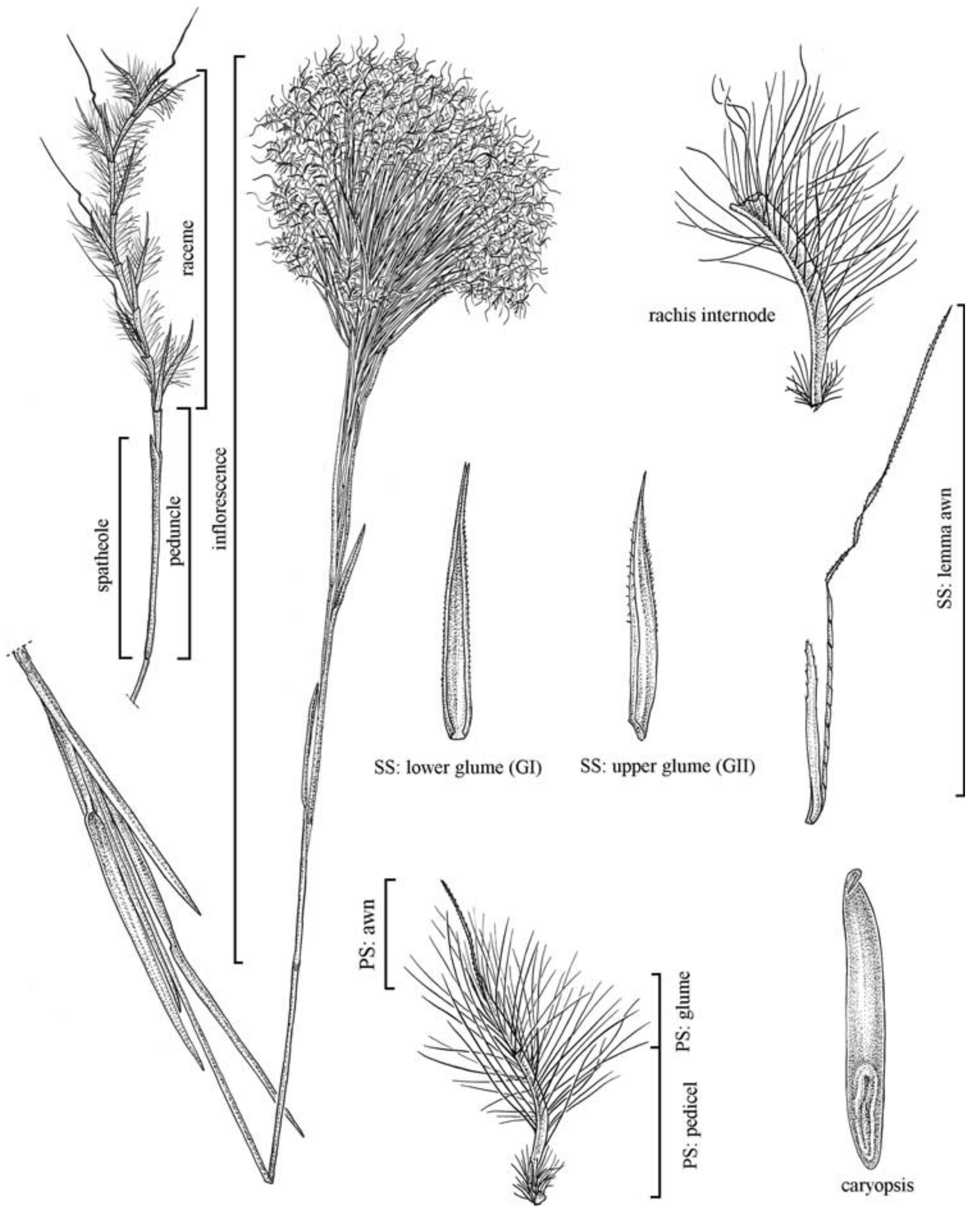


Fig. 1 *Schizachyrium* specimen exemplifying some of the studied morphological traits. *SS* sessile spikelet, *PS* pedicellate spikelet

Bartlett's test of homogeneity was made. Also, Tukey's test 5% was carried out to test differences between each pair of means.

With the aim to sort the specimens analyzed on the basis of their morphological similarities, and to identify the most important morphological traits in the demarcation of species and subspecies, a principal components analysis (PCA) was conducted. For the analysis, each specimen was treated as an operational taxonomic unit (OTU). A data matrix of 18 morphological quantitative variables × 294 OTUs was constructed. The details of the methods and procedures can be found at Sokal and Sneath (1963) and Crisci and López Armengol (1983).

A discriminant analysis (DA) from a data matrix of 294 OTUs × 22 variables was also performed to verify the consistency of the groups obtained in the PCA. The DA included both the continuous quantitative variables transformed by the Escoffier's method, and the standardized discrete quantitative variables. The qualitative variables were considered as double-state (Table 1). All statistical analyses were performed using the program Infostat 1.1 (Infostat 2002).

Results

The average values and standard deviation of the quantitative traits analyzed are summarized on Table 2. The distribution of some traits is portrayed in box plots of Fig. 2. One-way analysis of variance showed that the means of all the variables differ significantly among taxa (Table 2).

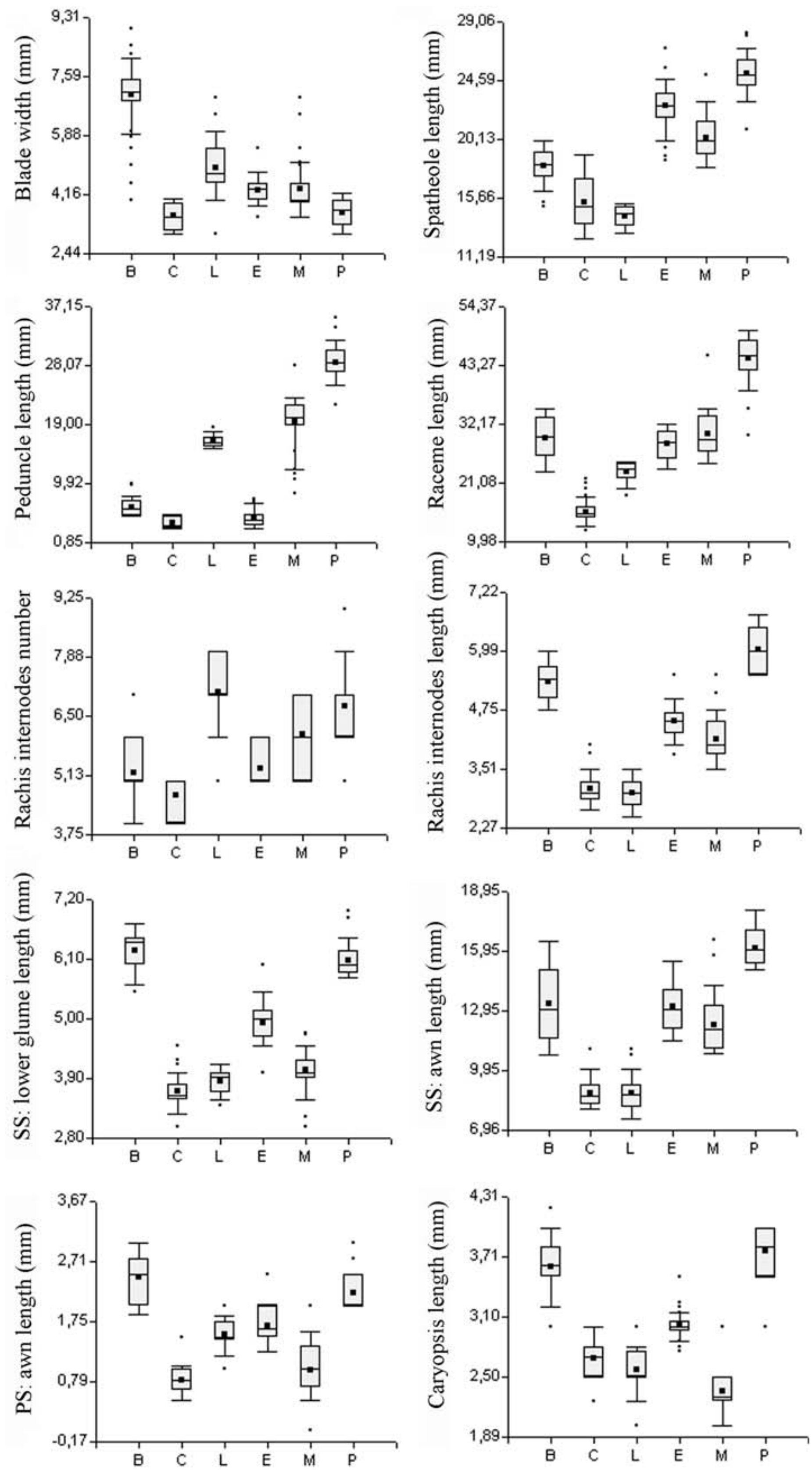
Table 2 Arithmetic average ± standard deviation, minimum and maximum values (in parentheses) for quantitative morphological traits of each species studied of *Schizachyrium*

Trait	*S. bimucronatum*	*S. condensatum*	*S. lactiflorum*	*S. microstachyum* subsp. *microstachyum*	*S. microstachyum* subsp. *elongatum*	*S. plumigerum*	*F* (ANOVA) *P*
Stem height	$76.96^{b} \pm 19.46$	$68.31^{b} \pm 18.70$	$75.52^{b} \pm 13.39$	$69.01^{b} \pm 21.80$	$75.35^{b} \pm 23.60$	$49.81^{a} \pm 11.11$	14.65
	(32.50–120.00)	(31.95–120.00)	(46.00–110.20)	(37.50–150.00)	(36.00–120.00)	(27.25–70.40)	<0.0001
Blade length	$109.76^{d} \pm 27.07$	$83.23^{ab} \pm 19.91$	$84.63^{ab} \pm 15.13$	$100.21^{cd} \pm 20.80$	$94.82^{bc} \pm 19.37$	$82.58^{a} \pm 15.69$	14.85
	(68.00–185.00)	(50.00–130.50)	(65.30–140.00)	(65.80–150.70)	(65.00–135.00)	(60.00–130.00)	<0.0001
Blade width	$7.08^{d} \pm 0.97$	$3.52^{a} \pm 0.43$	$4.93^{c} \pm 0.82$	$4.33^{b} \pm 0.74$	$4.29^{b} \pm 0.41$	$3.63^{a} \pm 0.42$	187.18
	(4.00–9.00)	(2.75–4.50)	(3.00–7.00)	(3.50–7.00)	(3.50–5.50)	(3.00–4.50)	<0.0001
Ligule length	$1.57^{ab} \pm 0.29$	$1.65^{ab} \pm 0.24$	$1.76^{b} \pm 0.22$	$1.72^{ab} \pm 0.50$	$1.57^{ab} \pm 0.29$	$1.56^{a} \pm 0.28$	3.52
	(1.00–2.00)	(1.20–2.00)	(1.20–2.00)	(1.00–3.50)	(1.00–2.00)	(1.00–2.00)	0.0042
Inflorescence length	$20.05^{b} \pm 5.02$	$10.68^{a} \pm 3.54$	$12.74^{a} \pm 3.90$	$29.32^{c} \pm 9.70$	$36.91^{d} \pm 11.97$	$27.83^{c} \pm 6.91$	89.94
	(8.85–32.00)	(6.75–22.00)	(7.50–22.35)	(16.80–70.00)	(17.80–72.00)	(17.50–42.00)	<0.0001
Inflorescence internodes number	$9.94^{cd} \pm 1.24$	$8.95^{b} \pm 1.61$	$9.28^{bc} \pm 1.24$	$10.50^{d} \pm 1.60$	$10.45^{d} \pm 1.48$	$5.57^{a} \pm 0.90$	65.71
	(7.00–12.00)	(7.00–13.00)	(7.00–12.00)	(8.00–15.00)	(8.00–13.00)	(4.00–7.00)	<0.0001
Spatheole length	$18.11^{c} \pm 1.31$	$15.33^{b} \pm 2.24$	$14.27^{a} \pm 0.85$	$20.26^{d} \pm 1.91$	$22.65^{e} \pm 1.71$	$25.10^{f} \pm 1.59$	311.41
	(15.00–20.00)	(12.00–20.00)	(12.50–15.60)	(17.00–25.00)	(18.50–27.00)	(20.85–28.25)	<0.0001
Peduncle length	$6.25^{b} \pm 1.41$	$3.89^{a} \pm 0.91$	$16.38^{c} \pm 0.99$	$19.48^{d} \pm 3.83$	$4.59^{a} \pm 1.29$	$28.54^{e} \pm 2.71$	1057.13
	(3.50–10.00)	(2.50–5.60)	(14.35–18.50)	(8.50–28.00)	(3.00–7.50)	(22.00–35.50)	<0.0001
Raceme length	$29.63^{c} \pm 4.21$	$15.58^{a} \pm 2.31$	$23.07^{b} \pm 1.95$	$30.30^{c} \pm 4.55$	$28.46^{c} \pm 3.22$	$44.59^{d} \pm 4.76$	262.21
	(22.00–36.75)	(12.00–22.00)	(18.75–25.75)	(22.00–45.00)	(22.00–34.30)	(30.00–52.35)	<0.0001
Rachis internodes number	$5.19^{b} \pm 0.77$	$4.66^{a} \pm 0.53$	$7.07^{d} \pm 0.86$	$6.08^{c} \pm 0.92$	$5.28^{b} \pm 0.56$	$6.74^{d} \pm 0.82$	63.92
	(4.00–7.00)	(4.00–6.00)	(5.00–8.00)	(5.00–8.00)	(4.00–6.00)	(5.00–9.00)	<0.0001
Rachis internodes length	$5.33^{d} \pm 0.44$	$3.09^{a} \pm 0.38$	$3.03^{a} \pm 0.34$	$4.13^{b} \pm 0.46$	$4.50^{c} \pm 0.36$	$6.02^{e} \pm 0.52$	394.45
	(4.50–6.05)	(2.50–4.00)	(2.50–3.70)	(3.50–5.50)	(3.80–5.50)	(5.00–7.00)	<0.0001
SS: lower glume length	$6.26^{d} \pm 0.42$	$3.65^{a} \pm 0.31$	$3.85^{ab} \pm 0.24$	$4.05^{b} \pm 0.38$	$4.92^{c} \pm 0.40$	$6.08^{d} \pm 0.36$	505.55
	(5.50–7.00)	(3.00–4.50)	(3.40–4.30)	(3.00–4.75)	(4.00–6.00)	(5.50–7.00)	<0.0001
SS: upper glume length	$5.35^{d} \pm 0.42$	$3.52^{a} \pm 0.34$	$3.67^{a} \pm 0.30$	$4.08^{b} \pm 0.39$	$4.99^{c} \pm 0.37$	$5.86^{e} \pm 0.34$	341.62
	(4.50–6.00)	(2.85–4.50)	(3.00–4.25)	(3.10–4.90)	(4.00–5.65)	(5.00–6.80)	<0.0001
SS: awn length	$13.28^{c} \pm 2.11$	$8.80^{a} \pm 0.78$	$8.79^{a} \pm 0.85$	$12.25^{b} \pm 1.42$	$13.14^{c} \pm 1.40$	$16.10^{d} \pm 1.06$	213.96
	(10.00–17.50)	(7.65–11.00)	(7.50–11.00)	(10.50–16.50)	(10.50–16.00)	(14.30–18.40)	<0.0001
PS: glume length	$2.53^{b} \pm 0.37$	$1.53^{a} \pm 0.25$	$1.68^{a} \pm 0.19$	$1.61^{a} \pm 0.33$	$1.69^{a} \pm 0.31$	$2.47^{b} \pm 0.42$	97.88
	(1.80–3.50)	(1.00–2.00)	(1.50–2.00)	(1.00–2.20)	(1.20–2.50)	(1.50–3.50)	<0.0001
PS: pedicel length	$5.05^{d} \pm 0.57$	$3.13^{b} \pm 0.43$	$2.61^{a} \pm 0.22$	$4.25^{c} \pm 0.61$	$4.45^{c} \pm 0.36$	$5.42^{e} \pm 0.58$	245.16
	(4.00–6.50)	(2.50–4.00)	(2.25–3.00)	(3.00–5.50)	(3.75–5.20)	(4.50–7.00)	<0.0001
PS: awn length	$2.45^{d} \pm 0.50$	$0.81^{a} \pm 0.24$	$1.54^{b} \pm 0.27$	$0.97^{a} \pm 0.46$	$1.68^{b} \pm 0.37$	$2.21^{c} \pm 0.28$	153.55
	(1.50–3.50)	(0.45–1.50)	(1.00–2.00)	(0.00–2.00)	(1.00–2.50)	(1.75–3.00)	<0.0001
Caryopsis length	$3.61^{d} \pm 0.30$	$2.68^{b} \pm 0.21$	$2.57^{b} \pm 0.24$	$2.35^{a} \pm 0.22$	$3.01^{c} \pm 0.14$	$3.76^{d} \pm 0.26$	187.17
	(3.00–4.20)	(2.25–3.00)	(2.00–3.00)	(2.00–3.00)	(2.75–3.50)	(3.00–4.20)	<0.0001

Values followed by the same letter are not significantly different

SS sessile spikelet, *PS* pedicellate spikelet

Fig. 2 *Box plots* representing the mean, median, interquartile range, adjacent values (*lines*), and outliers (*dots*) of some exomorphological characters in each species analyzed. **B** *S. bimucronatum*, **C** *S. condensatum*, **L** *S. lactiflorum*, **E** *S. microstachyum* subsp. *elongatum*, **M** *S. microstachyum* subsp. *microstachyum*, **P** *S. plumigerum*. *SS* sessile spikelet, *PS* pedicellate spikelet



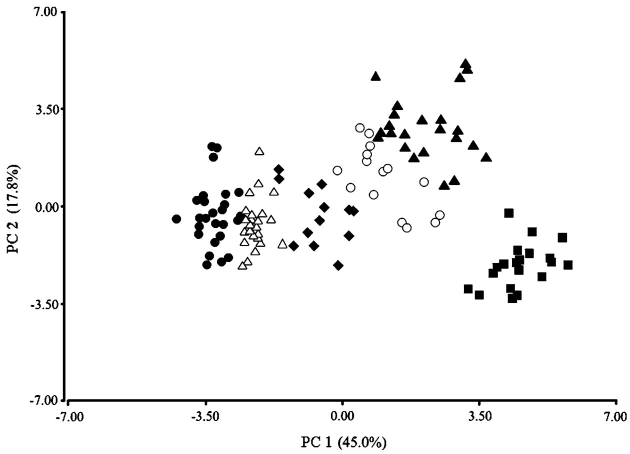


Fig. 3 PCA ordination diagram of 294 specimens and 18 morphological traits. The accessions of the different species are represented by the following symbols: filled triangle *S. bimucronatum*, filled circle *S. condensatum*, open triangle *S. lactiflorum*, filled diamond *S. microstachyum* subsp. *microstachyum*, open circle *S. microstachyum* subsp. *elongatum* and filled square *S. plumigerum*. *PC 1* principal component 1, *PC 2* principal component 2

Table 3 Contribution of the variables to components 1 (PC1) and 2 (PC2)

Variable	PC 1	PC 2
Stem height	0.04	**0.45**
Blade length	0.06	**0.45**
Blade width	0.08	**0.39**
Ligule length	−0.04	0.04
Inflorescence length	0.18	0.21
Inflorescence internodes number	−0.12	**0.46**
Spatheole length	**0.28**	−0.07
Peduncle length	0.17	**−0.29**
Raceme length	**0.31**	−0.11
Rachis internodes number	0.09	**−0.23**
Rachis internodes length	**0.33**	0.03
SS: lower glume length	**0.32**	0.12
SS: upper glume length	**0.33**	0.06
SS: awn length	**0.31**	−0.05
PS: glume length	**0.26**	0.02
PS: pedicel length	**0.31**	0.04
PS: awn length	**0.25**	0.04
Caryopsis length	**0.28**	0.06

Boldface depicts factor loadings of traits that most influence the PC axis 1 and 2

Principal components analysis

The first two components (Fig. 3) account for 62.8% (45 and 17.8%, respectively) of the morphological variation. The cophenetic correlation is high (0.91), indicating a good fit between the euclidean distance among OTUs in the two-dimensional plot and the distance in the original multidimensional space. The loadings of each variable to components 1 and 2 are shown in Table 3. Component 1 emphasizes differences in the length of spatheole, the raceme, the rachis internodes, the lower and the upper glume, the awn of the sessile spikelet, the caryopsis as well as in the glumes, the pedicel, and the awn of the pedicellate spikelet. This component allows differentiating specimens of *S. condensatum* and *S. lactiflorum*, which have negative values and are located to the left of the graph, from specimens of *S. bimucronatum* and *S. plumigerum* that have positive values and are located to the right (Fig. 3). The accessions belonging to the subspecies of *S. microstachyum* are arranged in the central part of the biplot. Component 2 accentuates differences in the stems length, the number of the inflorescence internodes, the leaf blade length and width, the peduncle length, and the number of the rachis internodes, setting apart *Schizachyrium plumigerum* from *S. bimucronatum* (Fig. 3).

Discriminant analysis

The centroids of each specimen are plotted in the space defined by the first two discriminant functions (Fig. 4), which explained 84.54% of the variation. Discriminant analysis results in a reliable classification of specimens of the different taxa, coinciding with the results obtained by means of PCA. The absolute values of the coefficients of the standardized discriminant functions are shown in Table 4. Characters that best discriminate along the canonical axis one (58.74% of the variation) are the blade length, the shape of the inflorescence and the upper portion of the spatheole, the peduncle length, and the apex of the lower glume. Canonical axis 2 (25.79% of the total variation) weights the shape of the inflorescence and of the upper portion of the spatheole, as well as the degree of exsertion of the peduncle at maturity as best identifier characters.

In the graphic obtained for discriminant analysis (Fig. 4) can be observed: (1) *S. plumigerum* and *S. microstachyum* subsp. *microstachyum* are located to the left and present panicle-like inflorescences, the upper portion of the spatheole heavily convolute, peduncle longer than 10 mm and with the upper portion exserted at maturity. However, other characters contribute to the recognition of these taxa. *S. plumigerum* presents fewer internodes (less than or equal to 7), shorter peduncle, spiciform raceme, rachis internodes, lower glume, and awn of the sessile and pedicellate spikelets, as well as a bigger caryopsis than *S. microstachyum* subsp. *microstachyum*. (2) The specimens of *S. microstachyum* subsp. *elongatum* are grouped in the middle portion of the graph, since they present panicle-like inflorescences, the upper portion of the spatheole open or

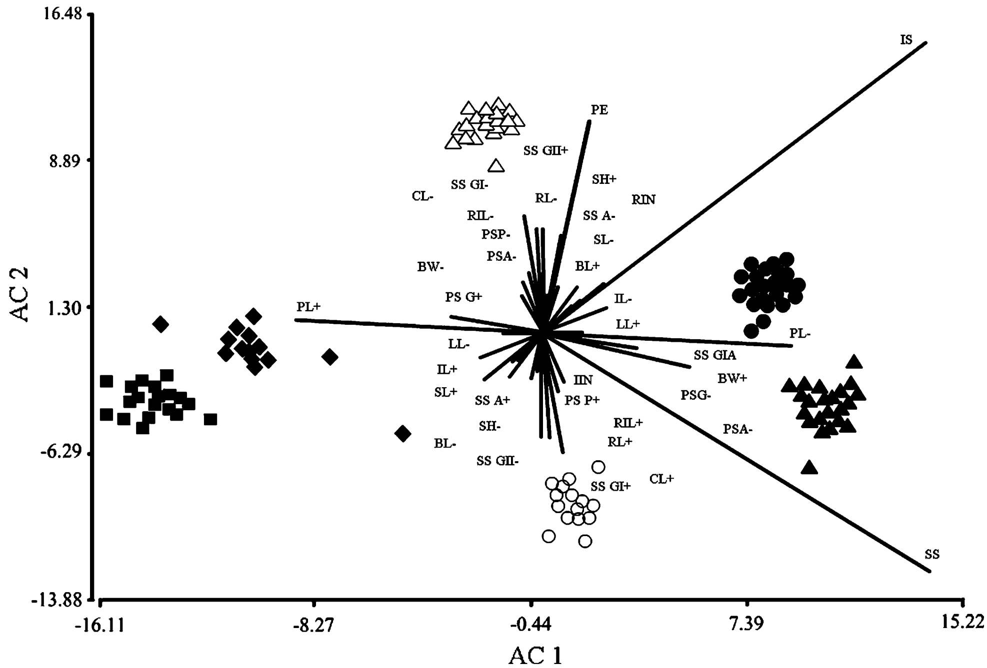


Fig. 4 Discriminant analysis of *Schizachyrium condensatum* and related species based on 22 morphological traits. The accessions of different species are represented by the following symbols: filled triangle *S. bimucronatum*, filled circle *S. condensatum*, open triangle *S. lactiflorum*, filled diamond *S. microstachyum* subsp. *microstachyum*, open circle *S. microstachyum* subsp. *elongatum* and filled square *S. plumigerum*. For explanation of abbreviations of morphological traits, see Table 1

subconvolute and peduncle shorter than 10 mm even at maturity. At the same intermediate position are the specimens of *S. lactiflorum*, but several traits that are correlated with the axis 2 split them apart. The traits that distinguish *S. lactiflorum* from *S. microstaehyum* subsp. elongatum and corymb-like inflorescence, the upper portion of the spatheole heavily convolute, and peduncle longer than 10 mm with the apical portion exserted at maturity. (3) *S. bimucronatum* and *S. condensatum* are located to the right and are characterized by their corymb-like inflorescences, the upper portion of the spatheole open or subconvolute, the peduncle shorter than 10 mm even at maturity. However, they can be differentiated by means of the leaf width and the length of raceme, rachis internodes, and spikelets. *S. bimucronatum* presents broad leaf blade usually wider than 5 mm; the raceme is longer than 25 mm; rachis internodes and glumes of the sessile spikelet are larger than 5 mm; the awn of the sessile spikelet is longer than 13 mm; caryopsis length is above 3 mm; the glume and awn of the pedicellate spikelet exceed 2 mm.

The classification function of discriminant analysis indicates that the probability to which group each of the specimens may belong was 100%, all the specimens being correctly assigned to each group.

Discussion

Our results show that multivariate methods based on vegetative and inflorescence traits allow the differentiation of *Schizachyrium condensatum* and related species, as Rosengurtt et al. (1968) proposed, using some quantitative inflorescence traits not used before. These results are in disagreement with Türpe (1984) who treated these taxa as a single species.

The analysis performed also evidences the reliability of several inflorescence traits in the identification of the different taxa. Among them, the length of spatheole, the peduncle, the spiciform raceme, the rachis internodes, the upper and lower glume, the caryopsis, the glumes and the awn of the pedicellate spikelet allow differentiating specimens of *S. condensatum* and *S. lactiflorum* from the specimens of *S. bimucronatum* and *S. plumigerum*. The recognition of the latter from the remaining species of the group had been attempted using intercarinal nerves and the width of the lower glume of the sessile spikelet (Rosengurtt et al. 1968). However, the number of nerves is not considered in our study, since, in most cases, it is scarcely noticeable and, therefore, not practical. Moreover, *S. plumigerum* was differentiated from *S. bimucronatum* by the inflorescence shape, the length of the peduncle, the spatheole, and the awn of the fertile lemma (Rosengurtt et al. 1968). Although the inflorescence shape and the peduncle length are useful in distinguishing both species, our results indicate that these taxa can also be readily separated from each other by means of the leaf blade width, the number of internodes of the main inflorescence axis, the shape of the spatheole, and the apex of the pedicellate spikelet.

Rosengurtt et al. (1968) distinguished *Schizachyrium condensatum* and *S. lactiflorum* by the length of the peduncle, the spiciform raceme, the rachis internodes and the sessile spikelet, as well as the number of rachis internodes, and the rough back of the lower glume of the sessile spikelet. Our results show that these species are better

Table 4 Contribution of the variables to the first and second canonical axis

Variable	E 1	E 2
Stem height −	−0.0027	−0.22
Stem height +	0.0027	0.22
Blade length −	**6.57**	**2.92**
Blade length +	**6.49**	**2.82**
Blade width −	0.27	0.04
Blade width +	−0.27	−0.04
Ligule length −	0.14	−0.04
Ligule length +	−0.14	0.04
Inflorescence length −	−0.19	0.15
Inflorescence length +	0.19	−0.15
Inflorescence shape	**−5.70**	**7.47**
Inflorescence internodes number	0.12	−0.10
Spatheole length −	−0.12	0.23
Spatheole length +	0.12	−0.23
Spatheole superior portion shape	**−7.04**	**−5.21**
Peduncle length −	**−2.24**	−0.11
Peduncle length +	**2.24**	0.11
Peduncle position	0.03	**2.28**
Raceme length −	0.14	0.34
Raceme length +	−0.14	−0.34
Raceme rachis internodes number	0.34	0.79
Rachis internodes length −	−0.10	0.17
Rachis internodes length +	0.10	−0.17
SS: lower glume apex gluma inferior	**−1.57**	−0.37
SS: lower glume length −	0.01	0.67
SS: lower glume length +	−0.01	−0.67
SS: upper glume length −	0.17	−0.49
SS: upper glume length +	−0.17	0.49
SS: awn length −	0.08	0.25
SS: awn length +	−0.08	−0.25
PS: glume length −	0.02	−0.11
PS: glume length +	−0.02	0.11
PS: pedicel length −	0.09	0.24
PS: pedicel length +	−0.09	−0.24
PS: awn length −	0.14	9.7E-04
PS: awn length +	−0.14	−9.7E-04
Caryopsis length −	−0.10	0.14
Caryopsis length +	0.10	−0.14

Traits followed by plus and minus signs are the quantitative variables transformed by the Escoffier's method. Boldface values correspond to the traits that most contribute to canonical axis 1 and 2

distinguished by means of the length of the peduncle and the raceme, and the number of rachis internodes, since the range of variation of the remaining traits mostly overlapped.

The subspecies of *S. microstachyum* may be unequivocally distinguished by the shape of the inflorescence and the length of spatheole and peduncle. Besides these differences, the geographic distribution of subspecies *microstachyum* and *elongatum* largely overlaps and, although they frequently occur in sympatry, natural hybrids were not detected (Peichoto 2007). These facts suggest that both subspecies should be recognized as different species.

Among vegetative traits, the blade width proved to be taxonomically useful to distinguish *S. bimucronatum* from related species. The stem height, although differs significantly among species, varies deeply within *S. bimucronatum* according to the environment, individuals growing in shallow clay or stony soils being lower than those occurring in sandy soils (Peichoto 2007). Because of this variation, it was not considered as a consistent character, and thus it was not included in the identification key.

Summing up, the results of the multivariate analysis based on vegetative and inflorescence traits support the identity of *Schizachyrium condensatum* and related species as independent taxa. Based upon the information obtained, a new identification key for these taxa was constructed:

Key for the identification of *Schizachyrium condensatum* and related species

1–Rachis internodes usually 5–7 mm long, when shorter the apex of the lower glume of the sessile spikelet unequally bimucronate. Lower glume of the sessile spikelet 5.5–7 mm long. Awn of the pedicellate spikelet 2–3 mm long. Caryopsis 3–4.5 mm long.	2
1′–Rachis internodes usually less than 5 mm long, when longer the apex of the lower glume of the sessile spikelet acute or subacute, with the hyaline middle portion apparently bifid. Lower glume of the sessile spikelet 3–5.5 mm long. Awn of the pedicellate spikelet lesser than 2 mm long. Caryopsis 2–3 mm long.	3
2–Widely panicle-like inflorescence, with four to seven internodes in the main axis. Spatheole 20–30 mm long, convolute strongly. Peduncle 20–35 mm long, upper portion (to 1/4 of the length) exserted at the maturity. Sessile spikelet: apex of the lower glume acute or subacute, the awn (14–) 15–20 mm long. Pedicellate spikelet with a minute tooth at the base of the awn. Leaf blade 3–4.5 mm wide.	*S. plumigerum*
2′–Corymb-like inflorescence, with more than seven internodes in the main axis. Spatheole 15–20 mm long, subconvolute. Peduncle (3.5-) 5–10 mm long, included at maturity. Sessile spikelet: apex of the lower glume bimucronate, awn generally 10–15 mm long. Pedicellate spikelet mucronate (0.5 mm long) at the base of the awn. Leaf blade (5–) 7–9 mm wide.	*S. bimucronatum*

Table a continued

3–Panicle-like inflorescence. Spatheole 13–17.5 (−18) mm long. Racemes usually longer than 25 mm, rarely shorter. Awn of the sessile spikelet 11–16 mm long.	4
3′–Corymb-like inflorescence, strongly capitatae. Spatheole 18–25 mm long. Racemes 12–25 mm long. Awn of the sessile spikelet 7.5–10 (–11) mm long.	5
4–Wide inflorescence. Peduncle 15–30 mm long, with the superior portion exserted at maturity. Spatheole strongly convolute. Lower glume of the sessile spikelet 3.5–4.5 mm long. Caryopsis 2–2.6 mm long.	*S. microstachyum* subsp. *microstachyum*
4′–Elongate inflorescence. Peduncle 3–10 mm long, included at maturity. Spatheole open or subconvolute. Lower glume of the sessile spikelet 4.5–5.5 mm long. Caryopsis 2.75–3 mm.	*S. microstachyum* subsp. *elongatum*
5–Racemes 12–18 mm long, with four to five pairs of spikelets. Peduncle 3–5.5 mm long, at maturity generally included in the spatheole. Pedicellate spikelet with awn 0.5–1 (–1.5) mm long. Leaf blade 3–4 mm wide.	*S. condensatum*
5′–Racemes 20–25 mm long, with (5–) 6–8 pairs of spikelets. Peduncle 10–20 mm long, apical portion exserted at maturity. Pedicellate spikelet with awn 1–2 mm long. Leaf blade 4–5 (–6.5) mm wide.	*S. lactiflorum*

Acknowledgments We express our gratitude to the curators of the herbaria listed for loans and access to their collections. We thank Dr. María Mercedes Arbo for critical review of the manuscript, Liliana Gomez for the illustration, and two anonymous referees for their valuable comments. This work has been supported by grants of the Universidad Nacional del Nordeste. MCP is Postdoctoral Fellowship of the National Research Council of Argentina (CONICET) and VGSN is a member of the Carrera del Investigador Científico of CONICET.

Appendix

Material of *Schizachyrium* examined. The specimens are listed in alphabetical order of the collectors

Schizachyrium bimucronatum

ARGENTINA. **Corrientes**: 35 km SW from Santo Tomé, *Ahumada 3026* (CTES). 7 km E from Santa Rosa, *Arbo and Ferrucci 2172* (CTES). Reserva Natural Prov. Iberá, 27°30′S 56°33′W, *Arbo and Tressens 8329* (CTES). 6 km E from Santa Rosa, *Arbo* et al. *925* (CTES). Route 41, 27°52′22″S 56°29′59″W, *Arbo* et al. *8646* (CTES). 7 km E from Bella Vista, *Battu 9* (CTES). Riachuelo, *Caponio and Urbani 73* (CTES). Goya, *Carnevali 1414* (CTES). Mburucuyá, Ea. Santa Teresa, *Carnevali 5973* (CTES); *Carnevali 6154* (CTES). *Daciuk 83* (CTES). Mercedes, *Fernandez 489* (CTES). San Roque, 28°25′30″S 58°26′17″W, *Keller 955* (CTES). 32 km W from Ituzaingó, *Krapovickas* et al. *25369* (CTES). Santa Rosa, *Martinez Crovetto 11284* (CTES). From Laguna Brava to Riachuelo, *Martinez Crovetto and Schinini 10212* (CTES). Route 12, access to Ituzaingó, *Peichoto 20* (CTES). 19 km S from Bella Vista, *Schinini 6532* (CTES). Ea. 3 Marias, 27°50′S 59°W, *Schinini 34387* (CTES). Riachuelo, *Schinini and Ahumada 12355* (CTES). 21 km S from Loreto, *Schinini* et al. *8191* (CTES). Route 12, 21 km S from Goya, *Schinini* et al. *18951* (CTES). 11 km S from Mercedes, *Tressens* et al. *2415* (CTES). **Entre Ríos**: Concordia, 31°16′52″S 58°04′12″W, *Peichoto 115* (CTES). Santa Ana, 30°52′S 57°50′W, *Romanczuk* et al. *120* (CTES). **Misiones**: Route 12, 16.5 km from Candelaria, 27°33′33″S 55°35′55″W, *Peichoto 103* (CTES). Near Candelaria, 27°28′S 55°42′47″W, *Peichoto 105* (CTES). Ituzaingó, 40 km N from Galarza, *Quarín 3356* (CTES). Mercedes, *Renvoize* et al. *3709* (CTES). San Ignacio, *Schinini and Daviña 24726* (CTES). Concepción de la Sierra, *Vanni* et al. *4573* (CTES). **PARAGUAY**. **Amambay**: Entrance to Cerro Corá Park, 22°39′69″S 56°01′48″W, *Arbo* et al. *8868* (CTES). Route 3, 32 km NE from route 5, *Schinini and Dematteis 33858* (CTES). **Caaguazú**: Yaguarón, *Krapovickas* et al. *12253* (CTES). 24 km N from Caaguazú, *López* et al. *223a* (CTES). Yaguarón, *Pedersen 7559* (CTES). 5 km S from Yhú, 26°06′40″S 55°57′50″W, *Schinini* et al. *36126* (CTES). **Cordillera**: Cerro Caacupé, *Arenas 1224* (CTES). Slope of S. Miguel hill, Caacupé, *Insfran 1090* (CTES). Near from Tobaty, *Peichoto* et al. *123* (CTES). San Bernardino, *Rojas 14272* (CTES). Roquedal del Piraretá, *Schinini 16* (SI). Eusebio Ayala, *Schinini 2517* (CTES). Road from Caacupé to Tobaty, *Schinini 14602* (CTES). Cordillera de Altos, Co. de Caacupé, *Schinini 23876* (CTES). Valenzuela, *Sparre and Vervoors 1331* (CTES). **Paraguari**: San Pedro, 23°44′4.3″S 53°17′34.8″W, *Gonzalez and Lopez 745* (CTES). Piraretá-Peribebuy, *Schinini 1366* (CTES). Cerro Palacios, *Zardini* et al. *2477* (FCQ).

Schizachyrium condensatum

COLOMBIA. Palmilla in declivitati orientali montis Quindio, *André 1939* (K). Antoquia, Mun. Urrao, *Pohl and Betancur 15497* (NY). Cauca, *Wood 3931* (K). **ECUADOR**. Quito, *Hartweg 1460* (K). Pichincha, *Padilla 1095* (MO). **PERÚ**. Cusco, Machu-Picchu, *Ferreyra 2720* (USM). **BRASIL**. Mato Grosso do Sul, Mun. Terenos, *Allem and Vieira 2063* (MO). São Paulo, Estacão Florestal de Paraguaçu Paulista, 22°17′S 50°34′W, *Clayton 4628* (MO). Paraná, Pinhaes, *Dusén 14507* (SI). Brasilia, Riberão Torto, *Irwin* et al. *13094a* (MO). São Francisco de Paula, *Longhi-Wagner 9245* (ICN). São Joaquim, SC 438, km 50 from Lages, *Longhi-Wagner and Garcia 7341* (ICN). São Paulo, Itararé IAC, *Longhi-Wagner and Zanin 3159* (ICN). Senges, PR 151 km 193 from Jaguariaiva, 24°10′21.1″S 49°35′26.7″W, *Longhi-Wagner* et al. *8996* (ICN). São Luiz do Puruna towards Ponta Grossa, *Longhi-Wagner* et al. *9419* (ICN). Cruz Alta, *Rosengurtt* et al. *9600* (BAA). Ponta Grossa, *Swallen 8299* (MO). Bela Vista, *Swallen 9472* (MO). Mun. S. Pedro do Sul, *Valls* et al. *4602* (ICN). Lagoa Vermelha, *Zanin 381* (ICN). **BOLIVIA**. Nor Yungas, from Coroico to Coripata, *Beck 17567* (CTES). Franz Tamayo, Apolo 57 km towards Charasani, *Beck 18514* (LPB). Yungas, *Pentland 186* (P). Santa Cruz, Sara, Buenavista, *Steinbach 6953* (W). **ARGENTINA**. **Entre Rios**: Federación, Santa Ana, *Burkart and Gamerro 21611* (SI). Arroyo Tunas, *Burkart and Gamerro 21633* (SI). Concordia, *Burkart* et al. *23247* (SI). **Corrientes**: Route 156, 20 km NW from route 129, *Carnevali 4766* (CTES). 35 km NW from Paso de los Libres, *Carnevali 6176* (CTES). 11 km N from San Carlos, *Krapovickas et al. 24960* (CTES). Garruchos, *Krapovickas* et al. *25098* (CTES). Mburucuyá, *Pedersen 5332* (MO). Santo Tomé, Garruchos, *Pedersen 9133* (CTES). Concepción, Carambola, *Pedersen 14061* (CTES). 10 km NE from Santa Rosa, *Peichoto 84* (CTES). Route 38 towards Gdor. Virasoro, 27°48′38″S 56°16′52″W, *Peichoto 96* (CTES). San Roque, 1 km E from Paso Naranjito, *Peichoto 106* (CTES). Santo Tomé, Garruchos, *Quarín 463* (CTES). **Formosa**: Laishi, 25 km W from San Francisco de Laishi, 26°10′S 58°56′W, *Digiacomo 22* (CTES). Formosa, *Kermes 572* (BAB). Campos de Col. Uriburu, *Parodi 6828* (BAA). **Misiones**: Posadas, Santa Inés, *Parodi 5474* (BAA). Misiones, *Parodi 6828* (BAA). 10 km E from San José, *Peichoto 54* (CTES). Concepción de la Sierra, 2 km W from Apóstoles, *Vanni* et al. *4591* (CTES). Route 14, 10 km E from San José, *Vanni* et al. *4604* (CTES). **URUGUAY**. Campos del Uruguay, *Arechavaleta s.n.* (W). **Rivera**: Cerro Aurora, A. Paraguayo, *Rosengurtt 8411* (ICN).

Schizachyrium lactiflorum

BRASIL. **Distr. Federal**: Parque municipal do Gama, ca. 20 km S from Brasilia, *Irwin and Soderstrom 5788* (MO). 2 km S from Sobradinho, *Irwin* et al. *9051* (MO). Brasilia, Riberão Torto, *Irwin* et al. *13094b* (MO). **Goiás**: Alto Paraiso-Teresina, 13°54′28.2″S 47°22′56.3″W, *Boechat and Filgueiras 83* (ICN). **Mato Grosso do Sul**: Rod. MS-295, Fazenda Bonanza, 35 km W from Amambai, *Hatschbach* et al. *58707* (CTES). **Minas Gerais**: Serra do Espinhaço, ca. 27 km SW from Diamantina, *Irwin* et al. *21939* (MO). **Paraná**: 8 km NE from Paraná-Santa Catarina, *Davidse* et al. *11038* (MO). Ca. 25 km W from Ponta Grossa, *Davidse* et al. *11363* (MO). 17 km N from Castro along Highway PR-11, *Davidse et al. 11391* (MO). Capão da Imbuia-Curitiba, *Dombrowski 5836* (MO). Mun. Curitiba, Capão da Imbuia, *Dombrowski 5991* (CTES). Rio da Ferra Vermelha, *Dusen 7834* (MO). Curitiba, *Swallen 8578* (MO). **São Paulo**: Av. Indianapolis, *Hoehne 3018* (ICN). Piraçicaba, Itararé, 24°12′59″S 49°12′56″W, *Souza* et al. *3586* (ESA). **PARAGUAY**. **Amambay**: National Park Cerro Corá, 22°39′30″S 56°00′04″W, *Arbo* et al. *8856* (CTES). Route 3, towards Bella Vista, *Arbo* et al. *8881* (CTES). National Park Cerro Corá, 22°38′S 56°04′W, *Brunner 1456* (G). National Park Cerro Corá, *Fernandez Casas and Molero 4074* (G). Ruta 3, 41 km N from Aquidabán river, *Ferrucci* et al. *1465* (CTES). Sierra de Amambay, *Hassler 10074* (G). National Park Cerro Corá, *Mereles 3563* (FCQ). National Park Cerro Corá, 22°40′S 58°5′W, *Morrone and Pensiero 460* (FCQ). National Park Cerro Corá, Remonta Cué, 22°40′S 56°5′W, *Morrone and Pensiero 547* (FCQ). Near Aquidabán Niqui stream, 22°38′54″S 56°01′12″W, *Múlgura de Romero* et al. *3690* (CTES). Estancia Johayhú, *Peichoto* et al. *118* (CTES). National Park Cerro Corá, *Soria 5842* (FCQ). National Park Cerro Corá, *Soria 7630* (CTES). National Park Cerro Corá, *Soria 7928* (CTES). National Park Cerro Corá, *Vanni* et al. *1335* (CTES). **Caaguazú**: Yhú stream, *López* et al. *233* (CTES). Tacurú stream, *Mereles 7595* (CTES). 4 km N from Ihú, *Schinini 23041* (CTES). **Canendiyú**: Lagunita, *Jimenez and Marin 42* (CTES). Ñandurokai, *Jimenez and Marin 1984* (MO). Reserva Natural del Bosque Mbaracayú, *Schinini and Dematteis 33249* (CTES). **Central**: Paraguaria centralis: in regione lacus Ypacaray, *Hassler 12448* (G). **Concepción**: 70 km E from Concepción, *Krapovickas* et al. *14260* (CTES). **Cordillera**: km 59 from Tobatí to Caacupé, *Peichoto* et al. *125* (CTES). **San Pedro**: Near Aguaray-mi river, *López* et al. *349* (CTES). Estancia Carumbé, *Pedersen 11173* (CTES). **ARGENTINA**. **Corrientes**: San Miguel, 28°06′72″S 57°26′18″W, *Arbo* et al. *8829* (CTES). Route 12, 32 km W from Ituzaingó, *Krapovickas* et al. *25371* (CTES). Ituzaingó, *Martinez Crovetto 11157* (CTES). 19 km W from Ituzaingó, *Peichoto 22* (CTES). 10.5 km W from access to Ituzaingó, *Peichoto 62* (CTES). San Roque, between Paso Naranjito and Tatacuá, *Peichoto 80* (CTES). 12 km N from Loreto, *Schinini and Quarín 8555* (CTES).

Schizachyrium microstachyum subsp. *elongatum*

COLOMBIA. **Tolima**: Honda, *Pennell 3566* (MO). **VENEZUELA**. **Apure**: distr. San Fernando, Isla Arapuca, *Davidse and González 12170a* (MO). **Barinas**: 16 km SW of the Meride intersection just outside of Barinas, *Davidse 3166* (MO). **Bolivar**: Mun. Raul Leoni, Aza Karon, 6°19′10″N 63°31′35″W, *Diaz and Delgado 673* (MO). **Miranda**: Colonia Tovar, *Escalona and Escalona V265* (MO). **Cojedes**: Hato Paraima, 9°26′N 68°10′W, *Ramia and Ortiz 8828* (MO). **ECUADOR**. **Imbabura**: km 41 from Lita-Salinas, 00°43′N 78°13′W, *Laegaard 71336* (MO). **Loja**: Near Yangana, *Hart 1027* (MO). **Pichincha**: Calderon, 00°05′S 78°23′W, *Laegaard 51714* (MO). **PERU**. **Amazonas**: Luya, *Diaz* et al. *3455* (MO). **San Martin**: Lamas, Alonso de Alvarado, *Schunke 6289* (MO). **BRASIL**. **Bahia**: Mun. Prado, 10.5 km NE of turn off road to Prado on road to Cumuruxatiba, 17°08′S 39°25′W, *Thomas* et al. *10032* (MO). **Goiás**: Rod. GO-118, 45 km S from São Gabriel de Goiás, *Hatschbach* et al. *70595* (CTES). **Mato Grosso do Sul**: Rod. MS-195, 15 km E from Iguatemi, *Hatschbach* et al. *58634* (CTES). **Pará**: Braganza Raibroad, *Goeldi 25* (MO). **São Paulo**: Mun. San Carlos, 25°58′S 47°55′W, *Eiten* et al. *3006* (MO). **BOLIVIA. Chuquisaca**: Luis Calvo, *Saravia Toledo 13528* (CTES). **Santa Cruz**: Pampa de Viru Viru, 17°39′46″S 63°09′24″W, *Menacho* et al. *320* (CTES). Vallegrande, *Saravia Toledo 12425* (CTES). **Tarija**: Arce, Rio Negro, *Meyer* et al. *20723* (CTES). **PARAGUAY**. **Alto Paraná**: 2 km N from Hernandarias, 25°17′S 54°35′W, *Schinini and Caballero Marmori 27311* (CTES). **Amambay**: National Park Cerro Corá, *Ferrucci* et al. *1389* (CTES). Route 3, 33 km N from Aquidabán river, *Peichoto* et al. *119* (CTES). Near P.J.Caballero, 22°35′12″S 55°44′24″W, *Schinini et al. 36027* (CTES). **Caaguazú**: 24 km N from Caaguazú, *López* et al. *223* (CTES). **Boquerón**: 12 km S from Filadelfia, *Vanni* et al. *2454* (CTES). **Misiones**: 12 km W from San Ignacio, *Arbo* et al. *1854* (CTES). **ARGENTINA**. **Catamarca**: Alta Gracia, *Stuckert 14170b* (MO). **Corrientes**: Route 38, near Gdor. Virasoro, *Peichoto 18* (CTES). 23 km E from Ituzaingó, *Peichoto 25* (CTES). Road to Colonia Garabí, *Tressens and Barrett 5167* (CTES). **Entre Rios**: Nacional Park El Palmar, *Cusato* et al. *1169* (CTES). 16 km W from Sta. Ana, 30°48′51″S 57°54′56″W, *Peichoto 112* (CTES). **Formosa**: Laishi, 25 km W from San Francisco de Laishi, 26°10′S °56′W, *Digiacomo 23* (CTES). **Jujuy**: Capital, Sierra de Zapla, *Cabrera* et al. *23719* (CTES). Mina 9 de Octubre, Sierra de Zapla, *Zuloaga and Deginani 180* (CTES). Sierra de Zapla, 24°13′S 65°04′W, *Zuloaga* et al. *5854* (MO). **Misiones**: Route 110, 30 km N from Apóstoles, *Carnevali 3386* (CTES). 18 km NW from Concepción de la Sierra, *Krapovickas* et al. *15082* (CTES). Loreto, *Martinez Crovetto 11211* (CTES). Concepción de la Sierra, 27°57′29″S 55°40′33″W, *Peichoto 97* (CTES). 14 km NW from Alem, 27°32′08″S 55°26′17″W, *Peichoto 100* (CTES). **Tucumán**: Tafi, *Crudelli 805* (CTES). **Salta**: Los Toldos, *Meyer* et al. *20439* (CTES). **Santa Fe**: Rosario, *Lewis and Collantes 13* (CTES). **URUGUAY**. **Colonia**: Ruta 5, N from Manuel Diaz, *Rosengurtt 8522* (SI). **Rivera**: between Rivera and Tacuarembó, *Dematteis and Schinini 1492* (CTES). **Salto:** Belén, 30°50′09″S 57°42′29″W, *Peichoto* et al. *34* (CTES). **Tacuarembó**: Tacuarembó, road to Gruta de los Helechos, *Dematteis and Schinini 1805* (CTES).

Schizachyrium microstachyum subsp. *microstachyum*

COLOMBIA. **Antioquia**: Mun. Andes, 10 km from Andes to Vereda Quebrada Arriba, *Fonnegra* et al. *2453* (MO). **Choco**: Rio Tolo, *Forero* et al. *955* (NY). **Narino**: *Barclay 4686* (MO). **Meta**: La Macarena Municipio, 2°40′N 74°10′W, *Ohba* et al. *680* (MO). **VENEZUELA**. **Bolívar**: Mun. Sucre, Maripa, *Elcoro 547* (MO). **Carabobo**: Mun. Autonomo Mora, 10°17–28′ N 68°10–16′ W, *Diaz 170* (MO). **Mérida**: NW of Mérida, *Bruijn 998* (NY). **GUYANA**. Cuyuni-Mazaruni, region Waramaden, 5°48′N 60°44′W, *McDowell and Goupal 3214* (MO). Pomeroon, Kabakaburi, 7°45′N 58°07′W, *Tiwari and Mengharini 331* (MO). **ECUADOR**. **Cotopaxi**: Quevedo-Latacunga, *Dodson and Embree 13430* (MO). Quevedo-Latacunga 00°52′S 79°09′W, *Holm-Nielsen* et al. *3161* (NY). **Tungurahua**: Baños, *Fagerlind and Wibon 1050* (NY). **PERÚ**. **San Martin**: Distrito San Martin, valley of San Martin, *Belshaw 3360* (MO). **Cusco**: Urubamba, Machu-Picchu, *Cabrera and Fabris 13510* (CTES). **Junin**: San Ramon de Pangoa, 40 km SE of Satipo, *Schuh and Schuh 10* (NY). **BRASIL**. Azambuja-Brusque, *Reitz s.n.* (SI). **Maranhão**: Carolina to San Antonio de Balsas, *Swallen 4836* (MO). **Mato Grosso**: Mun. de Caceres, Faz. Descalvados, *Allem* et al. *2410* (MO). **Matto Grosso do Sul**: Faz. Nhumirin, Nhecolandia, *Grandi 2761* (MO). **Minas Gerais**: Diamantina, 18°10′16.4″S 43°38′15.7″W, *Longhi-Wagner* et al. *9185* (ICN). **Paraná**: Rio de Terra Vermelha, *Dusen 7807* (BM). Ponta Grossa, *Swallen 8428* (MO). **Río Grande do Sul**: Pelotas, *Costa Sacco 95* (MO). Rio Pardo, *Palacios-Cuezzo 955* (CTES). **São Paulo**: Praia Grande, *Sendulsky 1090* (MO). **BOLIVIA**. **La Paz**: Sud Yungas, La Paz, Irupana 16°28′S 67°20′W, *Beck 22374* (CTES). Velasco, Reserva Forestal Bajo Paragua, 15°14′S 61°30′W, *Guillen* et al. *1091* (CTES). **Santa Cruz**: Sandoval, 16°19′39″S 58°26′25″W, *Solis Neffa* et al. *1590* (CTES). **Tarija**: Arce, Campamento Rio Negro, *Meyer 17460* (CTES). **PARAGUAY**. **Canendiyú**: Reserva Natural del Bosque Mbaracayú, 24°9′S 55°15′W, *Schinini and Dematteis 33340* (CTES). **Concepción**: Route 3 and route 5, 22°44′S 56°16′W, *Schinini and Dematteis 33426* (CTES). **Cordillera**: Near Tobaty, *Peichoto* et al. *124* (CTES). **Guairá**: Col. Independencia, 25°40′S 56°12′W, *Schinini* et al. *27980* (CTES). **ARGENTINA**. **Catamarca**: Andalgalá, *Jorgensen 1781* (SI). **Córdoba**: Prope Tanti, Villa

Garcia, *Stuckert 20466* (W). ‘Las Rosas′prope de La Falda, *Stuckert 16891* (MO). **Corrientes**: route 12, 25 km E from Corrientes, *Ahumada 1623* (CTES). Route 40, from Garruchos, *Cabrera* et al. *28450* (SI). 36 km SE from route 12 and 38, *Peichoto 26* (CTES). **Entre Ríos**: Isla Puente, *Keller 1550* (CTES). Concordia, 31°17′17″S 58°01′44″W, *Peichoto 117* (CTES). **Formosa**: Pirané, *Morel 580* (MO). **Jujuy**: Laguna de Yala, 24°07′ S 65°27′ W, *Zuloaga* et al. *6138* (CTES). **Misiones**: 14 km NW from Alem, 27°32′08″ S 55°26′17″ W, *Peichoto 101* (CTES). Concepción de la Sierra, *Vanni* et al. *4577* (CTES). **Salta**: Campo Quijano, *Meyer 3479* (MO). **Santiago del Estero**: Bandera, *Renolfi 88* (BAB). Belgrano, *Unamuno 44* (CTES). **Tucumán**: Burruyacú, *Venturi 2187* (MO). **URUGUAY**. **Maldonado**: La Barra, 34°54′24″S 54°49′15″W, *Peichoto et al. 43* (CTES). **Salto**: Belén, 30°50′09″S 57°42′29″W, *Peichoto* et al. *35* (CTES). **Tacuarembó**: 10 km NW from Tacuarembó, *Dematteis and Schinini 1805* (CTES). **Treinta y Tres**: Quebrada de los Cuervos, *Dematteis and Schinini 1618* (CTES).

Schizachyrium plumigerum

BRASIL. **Rio Grande do Sul**: Pelotas, *Irmão Gilberto 19* (ICN). 37 km from Pelotas, *Krapovickas* et al. *22890* (CTES). Cidreira, *Longhi-Wagner 9096* (ICN). Osorio-Balneario Atlantida, *Valls 2656* (ICN). **PARAGUAY**. **Boquerón**: 30 km SE from Loma Plata, 22°30′S 60°W, *Vanni* et al. *2234* (CTES). **ARGENTINA**. **Buenos Aires**: Pdo. Cnel. Dorrego, Monte Hermoso, *Arroyo 14185* (CTES). Garin, *Calderón 15477* (BAA). Sierras de Curramalan (Pigüe), *Ducos 3205* (BAA). Pellegrini, *León 373* (BAA). Sierra de la Ventana, *Proyecto Ventania 1033* (CTES). **Córdoba**: *Castellanos 21* (SI). 5 km E from Villa Huidobro, *León 3103* (BAA). **Corrientes**: Near Santa Rosa, *Arbo and Ferrucci 2200* (CTES). Santa Rosa, *Martinez Crovetto 11285* (CTES). Riachuelo, *Martinez Crovetto and Schinini 10221* (CTES). Mercedes, *Millán 392* (SI). Capital, *Parodi 12005* (BAA). Mburucuyá, *Pedersen 536* (BAA). San Cosme, Santa Ana, *Pedersen 6402* (CTES). Mocoretá, 30°21′47″S 57°57′34″W, *Peichoto 109* (CTES). 10 km S from Corrientes, Riachuelo, *Schinini 10749* (CTES). Paso de los Libres, *Schinini et al. 17340* (CTES). **Entre Rios**: Concordia, *Burkart 848* (SI). Dpt. Uruguay, *Burkart 24077* (CTES). Santa Ana, *Burkart and Gamerro 21615* (SI). Concordia, *Clos s.n.* (BAA). 14 km from Sta. Ana, 30°51′24″S 57°53′38″W, *Peichoto 113* (CTES). Concordia, 31°16′52″S 58°04′12″W, *Peichoto 114* (CTES). 11 km NW from Santa Rosa, *Tressens* et al. *943*b (ICN). **Formosa**: 25 km NW from Lomitas, *Fortunato* et al. *3421* (BAB). **La Pampa**: Anguil, *Ellenberg 617* (BAA). General Acha, *Magariños 15505* (BAA). 20 km from Makachin, *Rúgolo 1045* (SI). **San Luis**: Dpt. General Pedernera, 18 km S from Nva. Escocia, *Rosa E. 82* (CTES). **Santa Fe**: Castellanos, *Pensiero and Alonso 1157* (CTES). Sta. Rosa, *Romano s.n.* (BAA). **Santiago del Estero**: Alberdi, est. Santo Domingo, *Kunst* et al. *49* (CTES). **URUGUAY**. **Canelones**: Balneario Carrasco, *Legrand 55* (BAA). **Cerro Largo**: *Dematteis and Schinini 1576* (CTES). Punta Gorda, *Rosengurtt* et al. *8647* (BAA). **Colonia**: Araminda, *Rosengurtt 11085* (CTES). **Maldonado**: Bahia, *Rosengurt s.n.* (BAA, P). **Montevideo**: *Legrand 46* (BAA). **Rivera**: Cerro, *Felippone 3041* (BAA). **Rocha**: La Pradera, *Rosengurtt 9924* (BAA). **San José**: Est. Pascual, *Herter 535a* (SI). Barrancas San Gregorio, *Rosengurtt 7710* (BAA). **Tacuarembó**: Kiyú, 34°41′40″S 56°46′16″W, *Peichoto* et al. *46* (CTES). Near School, N°87 Capón de la Yerba, 31°36′59″S 56°03′07″W, *Peichoto* et al. *51* (CTES).

References

Chippindall LKA (1955) A guide to the identification of grasses in South Africa. In: Meredith D (ed) The grasses and pastures of South Africa. Central New Agency, South Africa, pp 502–504

Clayton WD (1972a) Gramineae: Andropogoneae: *Schizachyrium*. In: Hutchinson J, Dalziel JM (eds) Flora of West Tropical Africa (2nd edn, revised by Hepper FN), vol 3, part 2. Governments of Nigeria, Ghana, Sierra Leone and the Gambia by the Crown Agents for oversea governments and administrations, London, pp 477–481

Clayton WD (1972b) Studies in the Gramineae: XXXI. The awned genera of Andropogoneae. Kew Bull 27:457–474

Clayton WD, Renvoize SA (1986) Genera Graminum. Grasses of the world. Kew Bull, Additional Series XIII. Her Majesty's Stationery Office, London

Clayton WD, Harman KT, Williamson H (2002) World grass species: descriptions, identification, and information retrieval. http://www.kew.org/data/grasses-db.html. Accessed 30 November 2005

Crisci JV, López Armengol MF (1983) Introducción a la teoría y práctica de la taxonomía numérica. Monografía 26, Washington, DC

Escoffier B (1979) Traitment simultané de variables qualitatives et quantitatives en analyse factorielle (Qualitatives et quantitatives). Les Cahiers de l′Analyse des Données 5(2):137–146

Filgueiras TS (2003) *Schizachyrium*. In: Soreng RJ, Pennington SJ (eds) Catalogue of new world grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae and Danthonioideae. Contr US Natl Herb 46:560–569

Gibbs Russell GE, Watson L, Koekemoer M, Smook L, Barker NP, Anderson HM, Dallwitz MJ (1990) Grasses of Southern Africa. Mem Bot Surv S Afr 58:288–290

Holmgren PK, Holmgren NH, Barnett LC (1990) Index herbariorum, part I: the herbaria of the world, 8th edn. New York Botanical Garden, New York

Infostat (2002) Version 1.1 Group Infostat FCA. Universidad Nacional de Córdoba, Argentina

Killeen T (1990) The grasses of Chiquitanía, Santa Cruz, Bolivia. Ann Missouri Bot Gard 77:125–201

Nicora EG, Rúgolo de Agrasar ZE (1987) Los géneros de Gramíneas de América Austral. Ed. Hemisferio Sur, Buenos Aires

Peichoto MC (2006) A new species of *Schizachyrium* (Poaceae: Andropogoneae) from Brazil. Bot J Linn Soc 150:495–501

Peichoto MC (2007) Estudios sistemáticos en las especies sudamericanas de *Schizachyrium* (Poaceae: Andropogoneae). Doctoral Thesis, Facultad de Ciencias Agrarias, Universidad Nacional del Nordeste

Peichoto MC, Vegetti A (2007) Synflorescence of species related to *Schizachyrium condensatum* (Poaceae). Flora 202:503–512

Pohl RW (1994) *Schizachyrium*. In: Davidse G, Sousa S, Chater AO (eds) Flora Mesoamericana, vol 6. Instituto de Biología, Universidad Nacional Autónoma de México, Mexico, pp 391–393

Renvoize SA (1984) The grasses of Bahia. Royal Botanical Gardens, Kew, pp 283–286

Renvoize SA (1988) Hatschbach's Parana grasses. Royal Botanic Gardens, Kew, pp 61–62

Renvoize SA (1998) Gramíneas de Bolivia. Royal Botanical Gardens, Kew, pp 600–605

Rosengurtt B, Arrillaga de Maffei BR, Izaguirre de Artucio P (1968) Especies nuevas y notas taxonómicas de gramíneas en Uruguay y Paraguay Las especies afines a *Schizachyrium condensatum* de Uruguay y Paraguay. Bol Fac Agron Univ Montevideo 103:25–41

Sokal RR, Sneath PH (1963) Principles of numerical taxonomy. Freeman and Co., San Francisco

Tovar G (1993) Las Gramíneas (Poaceae) del Perú. Ruizia 13:193–384

Türpe AM (1984) Revision of the South American species of *Schizachyrium* (Gramineae). Kew Bull 39:169–178

Watson L, Dallwitz JM (1992) The grass genera of the world. C.A.B International, Wallingford

Zanin A (2001) *Schizachyrium*. In: Longhi-Wagner HM, Bittrich V, Wanderley MGL, Shepherd GJ (eds) Flora Fanerogámica do Estado São Paulo, vol 1. HUCITEC, São Paulo, pp 110–112