



Article

On the taxonomic status of the genus *Thrasyopsis* (Poaceae, Panicoideae, Paspaleae): new combinations in *Paspalum*

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Abstract

The two species formerly assigned to the genus *Thrasyopsis* are transferred to *Paspalum*, on the basis of morphological and molecular evidence. The new combinations *Paspalum rawitscheri* and *P. repandum* are published.

Introduction

The genus *Thrasyopsis* Parodi (1946: 293) was originally described to accommodate what seemed to be a new species from southern Brazil, named *Thrasyopsis rawitscheri* Parodi (1946: 294). In the same paper, Parodi transferred to the new genus the species *Panicum repandum* Nees (1829: 98), also from southern Brazil, as *T. repanda* (Nees) Parodi (1946: 297). Later, Burman (1980) noticed that Parodi's species had been previously described as *Panicum juergensii* Hackel (1915: 70), and made the new combination *Thrasyopsis juergensii* (Hack.) Soderstrom ex A. G. Burman (1980: 221). In his taxonomic revision of the genus, Burman (1983) summarized the current knowledge of *Thrasyopsis*, discussed its relationship with related genera, provided good descriptions and illustrations of the two recognized species, and made comments about their distribution, suggesting that both species are quite rare.

Several authors (Parodi 1946, Burman 1983, Denham & Zuloaga 2007) pointed out the morphological affinities of *Thrasyopsis* with both the genus *Thrasya* Kunth (1816: 120, t. 39) and the informal group 'Decumbentes' of *Paspalum* Linnaeus (1759: 855), which have been recently merged into *Paspalum* subg. *Harpostachys* (Trinius 1834: 194) Denham (2005: 475). *Thrasyopsis* shares with *P.* subg. *Harpostachys* the occurrence of inflorescences that are frequently unispicate, and spikelets with a proximal male flower. *Thrasyopsis* and the species formerly included in *Thrasya* also share inflorescences with a foliaceous rachis, although this character also occurs in several unrelated species of *Paspalum* and can correlate with more than one anatomical structure (Aliscioni & Denham 2008). Denham & Zuloaga (2007) also mention as shared characters the presence of a pseudoligule and an obtuse lower glume.

According to Chase (unpublished manuscript), Parodi suggested in a memo to Swallen dated on October 1946 (Fig. 1) that the two species of *Thrasyopsis* should be transferred to *Paspalum* and are related to species of the informal group 'Crassa'.

In a morphology-based cladistic analysis (Denham & Zuloaga 2007), *Thrasyopsis* is placed as sister to *Paspalum* (including *Thrasya*). Nevertheless, the species sampling outside the section *Harpostachys* was very limited, so the relationship of *Thrasyopsis* with *Paspalum* remained to some extent unresolved.

Molecular data threw new light regarding the phylogenetic relationships of the *Thrasyopsis* species. According to them, the taxonomic status of *Thrasyopsis* should be reassessed.

Paspalum = *Crassa* group, chose ined. !
 J. Litt. Swollen 5 Oct. 1946

Varies
 spikes { *P. crassum* Chase, nongr. *Paspalum* p. 40, fig. 18
P. tumidum Kuhlman. (i don't find description?) of Chase op. cit. p. 40
P. cinerascens (Doell)

Una
 spica { *P. repandens* Br. = *Thrasypsis repanda* (Br.) Par.
P. Luykensis Hook. = " *Rawitscheri* Par.

Memorandum a
 Swollen - 22.8/46

FIGURE 1. Parodi's handwritten memorandum to Swallen, attached to the holotype of *T. rawitscheri* at BAA, in which relationship of *Thrasypsis* with *Paspalum* group 'Crassa' was suggested.

Material and methods

In the context of a phylogenetic analysis of the genus *Paspalum* (Rua *et al.* 2010), the two known species of *Thrasypsis* were collected and maintained in cultivation in a greenhouse at Embrapa Genetic Resources and Biotechnology, Brasília DF, Brazil. Transverse sections from the middle portion of rachises were made (Fig. 2) to compare their anatomy with the patterns described by Aliscioni and Denham (2008). Herbarium samples were re-hydrated in water with detergent for 72 h in a heater at 60 °C. Prior to infiltration, rachis fragments were pretreated with 20% fluorohydric acid during 24 hs to remove silica cells. The material was then dehydrated in an ethanol series and embedded in paraffin, and sectioned using a rotary microtome according to standard methods. Histological samples were deparaffined, stained with Safranin–Fast Green, and mounted in DPX. Observations were made using a Zeiss Axioplan light microscope, and photomicrographs were taken by a standard digital camera.

Results and discussion

Rachis anatomy:—Rachis transections correspond to the type III of Aliscioni and Denham (2008), since they show semicircular, solid keels with conspicuous sclerenchyma forming a complete ring, and uniformly-nerved lateral wings longer than the keel width (Fig. 2). Type III rachises have been found only in species of *Paspalum* subg. *Harpostachys*, thus anatomical data suggest a close relationship between that subgenus and *Thrasypsis*. Nevertheless, molecular evidence does not support such a relationship (Rua *et al.* 2010, Scataglini *et al.*, unpublished manuscript), as stated in the next paragraph.

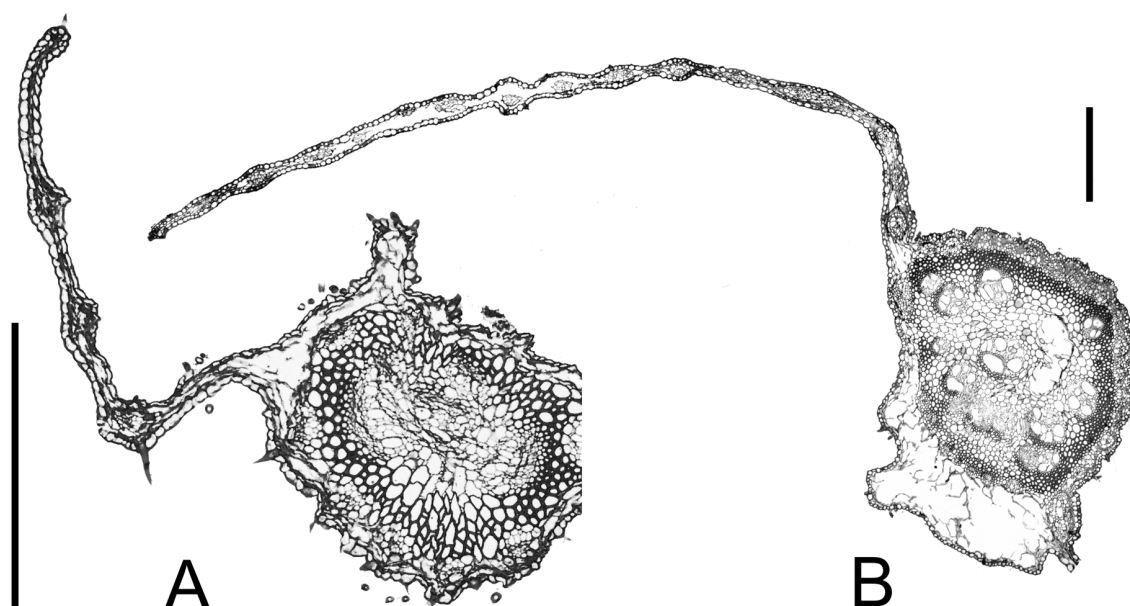


FIGURE 2. Transverse sections of rachises of both species formerly placed in *Thrasyopsis* and here transferred to *Paspalum*: A, *P. repandum* (Araujo 174, BAA), and B, *P. rawitscheri* (Rua & Rosa 728, BAA), scale bars 0.5 mm.

Phylogenetic relationships:—Recent phylogenetic analyses of *Paspalum* and allies based on different morphological and molecular markers (Rua *et al.* 2007, 2010, Scataglini *et al.* 2007 and unpublished manuscript) showed that both species of *Thrasyopsis* form a well supported clade deeply nested within *Paspalum* (Fig. 3), and just within a major clade, that includes, among others, the informal groups ‘*Notata*’, ‘*Plicatula*’ and ‘*Bertoniana*’ (‘NPBT-clade’ in Rua *et al.* 2010, corresponding to ‘Clade A’ in Scataglini *et al.* unpublished manuscript). Nevertheless, relationships within the NPBT-clade were poorly resolved, and the NPBT-clade itself was weakly supported, thus the phylogenetic relationships of the *Thrasyopsis* clade with other species of *Paspalum* remain ambiguous.

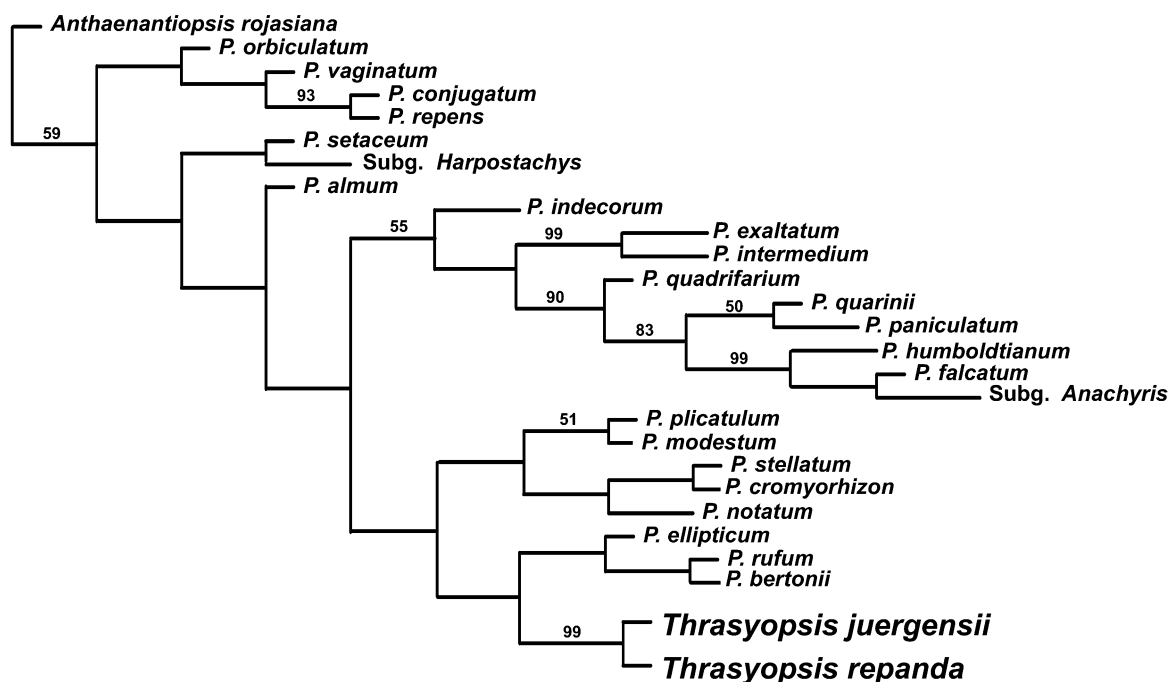


FIGURE 3. Simplified phylogeny of *Paspalum* based on 4 cpDNA markers (rnl intron, trnL-trnF spacer, atpB-rbcL spacer, and trnG intron, 2223 BP) and 115 morphological characters (redrawn from Rua *et al.* 2010), in which *Thrasyopsis* is deeply nested within *Paspalum*. Values above branches represent symmetric jackknife frequencies.

The ‘*Crassa*’ group was proposed by Chase (unpublished manuscript) to accommodate *P. crassum* Chase in Hitchcock (1913: 239) and *P. tumidum* Kuhlmann (1925: 349, t. 27) together with *Thrasyopsis juergensii* (under the combination *Paspalum rawitscheri* (Parodi) Chase). The group was characterized by including “tall coarse annuals or perennials with winged rachises and large glabrous spikelets”. In the memo to Swallen cited above (Fig. 1), Parodi considered an expanded ‘*Crassa*’ group, that included, in addition of Chase’s species, the other known species of *Thrasyopsis* as well as *P. cinerascens* (Döll 1877: 189) Burman & Bastos (1988: 241). *Paspalum cinerascens* has been otherwise included in subg. *Harpostachys* (Denham 2005). In fact, the inclusion of *P. cinerascens* in subg. *Harpostachys* as well as its relatively distant relationship with *Thrasyopsis* have been corroborated by recent molecular evidence (Rua *et al.* 2010, Scataglini *et al.*, unpublished manuscript). On the other hand, *P. crassum* and *P. tumidum* have been synonymized under *P. tumidum* (Zuloaga & Morrone 2003). Thus, what remains unresolved is the putative relationship of *Thrasyopsis* with *P. tumidum*, which unfortunately could not be tested, because no fresh material from that species was available, and DNA extraction and sequencing from herbarium material failed (P. Speranza pers. comm.).

Taxonomy:—As a result of the considerations above, the two species of *Thrasyopsis* should be subsumed within the genus *Paspalum*. In the context of the current infrageneric classification, they should belong to the large subgenus *Paspalum*, which however is most likely paraphyletic (Rua *et al.* 2010). Thus, the proper placement of *Thrasyopsis* species within *Paspalum* would remain uncertain until phylogenetic relationships among *Paspalum* species become clear and a robust phylogeny-based infrageneric classification become available. The new combinations follow:

Paspalum rawitscheri* (Parodi) Chase ex G. H. Rua & Valls, *comb. nov.

Basionym:—*Thrasyopsis rawitscheri* Parodi (1946: 294). Type:—BRAZIL. Paraná: Estrada Ponta Grossa a Tibagi, em campos, 14 February 1945, *Joly 17* (Holotype: BAA!).

Synonym:—*Thrasyopsis juergensii* (Hack.) Soderstrom ex A. G. Burman (1980: 221). *Panicum juergensii* Hackel (1915: 70), ‘jürgensii’. Type:—BRAZIL. Rio Grande do Sul: Lagão, Município Soledade, in campis siccis, 1912, *Jürgens G412* (Holotype: W; isotype: US [barcode] US00148598 digital image!).

Cespitose perennials with erect culms. Leaf sheaths sheltered by stiff, deciduous hairs, leaf blades rigid, long attenuate towards the base. Racemes mostly solitary, or eventually paired, 10–15 cm long, with rachis broadly winged, foliaceous, partially covering the spikelets. Spikelets paired, glabrous, lower glumes 0–5-nerved, up to ½ the length of the spikelets, sometimes wanting; upper glumes obovate, 13–17-nerved, the apex truncate overtopped by the excurrent nerves; lower floret male, the lower lemma 7–9-nerved, glume-like; upper floret bisexual.

Distribution, habitat, and conservation status:—Endemic to Southern Brazil, this relatively rare species occurs in ‘campos’ on outcropping areas in the states of Rio Grande do Sul, Santa Catarina and Paraná (Burman 1983, Filgueiras 2012). The species was classified as ‘vulnerable’ (Boldrini 2009) and included in the list of threatened species of the Brazilian flora, because of the progressive reduction of the already small number of surviving individuals in known populations (Valls *et al.* 2009).

Additional specimens examined:—*Paspalum rawitscheri*. BRAZIL. Rio Grande do Sul: Campestre da Serra, BR 116, km 65, segunda curva a esquerda após a ponte sobre o rio Canabarro, baixada com pedras na borda do capão, à direita da estrada, elev. 774 m, 28°40’45”S, 51°03’54”W, 09 February 2006, *Rua & Rosa 728* (CEN)

Nomenclatural notes:—Because of the previous existence of the name *Paspalum juergensii* Hackel (1909: 312, ‘jürgensii’), referring to a different species, the combination resulting from the transference of *Panicum juergensii* Hackel to *Paspalum* would be a later homonym. Thus, the species must be called *Paspalum rawitscheri* based on the earliest available epithet (McNeill *et al.* 2006, Art. 11.4). Such a combination has been formerly made by Chase (unpublished manuscript) but was never effectively published.

Paspalum repandum* (Nees 1829: 98) G. H. Rua & Valls, *comb. nov.

Basionym:—*Panicum repandum* Nees (1829: 98). *Thrasypopsis repanda* (Nees) Parodi (1946: 297). TYPE:—BRAZIL. “Brasilia australiore”, Barra do Pará (as “Bra. do Paxa”), date unknown, Sellow B.1246. C.194 (Holotype: B [barcode] B 10 0249432 digital image!; isotypes: BAA [barcode BAA0000622] fragment ex B!, US [barcode US00139930 p.p.] fragment ex B, digital image!; probable isotypes: G [barcodes G00168437, G00168438 and G00168439] digital images!, K [barcodes K000643320 and K000643322] digital images!, LE, P [P02328829 and P02328833] digital images!, US [barcode US00139930 p.p.] fragment ex LE, digital image!, W [W0030638] digital image!).

Cespitose perennials with erect culms. Leaf sheaths hirsute, fibrous and persistent after senescence, leaf blades flat, flexuous, pale, silvery-hirsute. Racemes paired or solitary, 1.5–4 cm long, with rachis narrowly winged, not covering the spikelets. Spikelets paired, subglabrous, lower glumes 5–7-nerved, up to $\frac{3}{4}$ the length of the spikelets; upper glumes obovate, cucullate, 11-nerved; lower floret usually male, the lower lemma 9-nerved, glume-like; upper floret bisexual.

Distribution, habitat, and conservation status:—Endemic from the Brazilian states of Minas Gerais, São Paulo (most ancient collections known from both states), and Paraná. This species has been consistently collected near Ponta Grossa (state of Paraná) in the vicinity of Vila Velha (Burman 1983). Nevertheless, we have recently conducted intensive field collections in this area and only found a single tuft. Although the current conservation status of this species has not yet been established, it is very likely to be a threatened species, because of its extreme rarity. Flowering of *Paspalum repandum* seems to be fire-dependent, since all known herbarium specimens are burned plants.

Additional specimens examined:—*Paspalum repandum*. BRAZIL. Paraná: Ponta Grossa, Faz. Vila Velha, BR-367, km 520, borda de barranco com arenito, elev. 915 m, 25°15'56"S, 49°58'50"W, 12 February 2006, Rua s.n. (CEN); id., 13 November 2010, Carmo et al. 22 (HUPG); Vila Velha, 26 November 1952, Araujo 174 (BAA).

Nomenclatural notes:—There are two descriptions for this species published in 1829: *Panicum repandum* Nees in Martius, *Flora Brasiliensis seu Enumeratio Plantarum* 2(1): 98–99, and *Panicum repandum* Nees ex Trin., *Species Graminum* 2(13): t. 150. The first work was published between March and June 1829, whereas the exact date of publication of the part 13 of *Species Graminum* is still unknown (Stafleu & Cowan 1986), so that it is impossible to know which of both publications is earlier. The original material on which the species was described was collected by Sellow in southern Brazil and originally deposited at B, where it was studied by Nees [*“Habitat in Brasilia australiori. (Sellow. Vidi in Herb. Reg. Berol.)”*], cf. Nees 1829: 99]. The specimen still conserved at B [barcode B 10 0249432] has a label in Sellow’s handwriting with the inscription “Bra. do Paxa, B 1246, c.194”, without indication of date. There is no place in Brazil with the name “Paxa”, and probably there is a handwriting mistake in Sellow’s label. Between 1814 and 1831, Sellow made six collection trips in Brazil. In the third trip across Minas Gerais, São Paulo and Rio de Janeiro, he double-numbered the specimens from about 2,500 locations under the letters B and c (Urban 1893), thus the type material of *P. repandum* belongs to this collection. The itinerary of Sellow’s trips detailed by Urban (1906: 105–112) casts light on the actual locality and date of collection: Sellow was in December 1818 in a place named “Barra do Pará”, i.e. the mouth of the Pará river in the São Francisco river, near the present town of Pompeu, in the state of Minas Gerais, and this is probably the locality where the plant was collected.

Trinius, who explicitly attributed the species to Nees, based his description and illustration on a sheet deposited at LE (LE-TRIN-0922.01), and labelled “*Panicum repandum* Nees ab Ess., Sellow, Brasilia, de Schlechtendal 27” (R. Soreng, pers. comm.). This specimen (not seen) is presumably a duplicate of the original Sellow’s material sent to Trinius by Schlechtendal. The hypothesis of Soreng that this specimen belongs to a collection of cultivated material from seeds of the Sellow plant (pers. comm., see also the entry for *P. repandum* in Tropicos.org (Missouri Botanical Garden 2012): “*F. Sellow; cult. coll. de Schlechtendal 27; Brasilia, cult. in Germany*”) seems improbable, because it is a plant difficult to bring into flower under cultivation since flowering seems to be fire-dependent (see above).

As exact publication dates of Trinius work are uncertain (Stafleu & Cowan 1986: 495), we prefer, in agreement with Soreng (comm. pers.) to take the Nees description (and the corresponding holotype at B) as the valid one, and consider *Panicum repandum* Nees ex Trin. as an isonym.

Further duplicates of the Sellow's collection were apparently distributed to several herbaria (G, K, P, W) by Schlechtendal, each specimen identified as *Panicum repandum* Nees in Schlechtendal handwriting on a label printed with the inscription "*Herb. Reg. Berolinense. Brasilia. Sellow legit.*", with no reference to numbering nor locality. On the other hand, fragments at BAA and US were taken directly from B by Lorenzo R. Parodi and M. Agnes Chase respectively, who transcribed the original Sellow's label. Further, a specimen at HAL that was indicated erroneously as the type of *Panicum repandum* (barcode HAL0063595, digital image!) corresponds to the species *Paspalum erianthum* Nees ex Trinius (1826: 121). This specimen has two labels in Schlechtendal handwriting, probably dated after Schlechtendal moved to Halle in 1833: one of the labels includes the proper identification followed by a latin description beginning with the expression *Panicum repandum spicam...*, the other label reads "*Panicum repandum N. ab E. Sellow. Brasilia...*"

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References

- Aliscioni, S.S. & Denham, S.S. (2008) Rachis of the genus *Paspalum* L. (Poaceae: Panicoideae: Paniceae): Anatomy and taxonomic significance of the primary branches of the inflorescences. *Flora* 203: 60–76.
- Boldrini, I.I. (2009) A flora dos Campos do Rio Grande do Sul. In: Pillar, V.P., Müller, S.C., Castilhos, Z.M.S. & Jacques, A.V.A. (eds.), *Campos Sulinos. Conservação e uso sustentável da biodiversidade*. Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Departamento de Conservação da Biodiversidade, Brasília/DF, pp. 63–77.
- Burman, A.G. (1980) Notes on the genera *Thrasya* H.B.K. and *Thrasyopsis* Parodi (Paniceae: Gramineae). *Brittonia* 32: 217–221.
- Burman, A.G. (1983) The genus *Thrasyopsis* Parodi (Gramineae). *Phyton (Austria)* 23: 101–116.
- Burman, A.G. & Bastos, M.N.C. (1988). A new species of *Thrasya* H.B.K. (Gramineae) from Brazil. *Boletim do Museu Paraense Emílio Goeldi, Série Botânica* 4: 235–241.
- Hitchcock, A.S. (1913) Mexican grasses in the United States National Herbarium. *Contributions from the United States National Herbarium* 17: 181–389.
- Chase, M.A. (Unpublished manuscript) *Paspalum of South America*. Washington D.C.: Hitchcock and Chase Library, Botany Department, Smithsonian Institution, 514 pp.
- Denham, S.S. (2005) Revisión sistemática del subgénero *Harpostachys* de *Paspalum* (Poaceae, Panicoideae, Paniceae). *Annals of the Missouri Botanical Garden* 92: 463–532.
- Denham, S.S. & Zuloaga, F.O. (2007) Phylogenetic relationships of the 'Decumbentes' group of *Paspalum*, *Thrasya* and *Thrasyopsis* (Poaceae: Panicoideae: Paniceae). *Aliso* 23: 545–562.
- Döll, J.C. (1877) Gramineae. In: Martius, C.F.P. & Eichler, W. (eds.), *Flora Brasiliensis* 2(2). F. Fleischer, München, pp. 1–358.
- Filgueiras, T.S. (2012) *Thrasyopsis*. In: Jardim Botânico do Rio de Janeiro, *Lista de Espécies da Flora do Brasil*. Available from: <http://floradobrasil.jbrj.gov.br/2012/FB013653> (Accessed: 28 October 2012).
- Hackel, E. (1909) Gramineae novae VI. *Repertorium Specierum Novarum Regni Vegetabilis* 7: 311–327.
- Hackel, E. (1915) Neue Gräser aus Brasilien. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* 65: 70–77.

- Kuhlmann, J.G. (1925) Contribuição para o conhecimento de algumas plantas novas, contendo também um trabalho de crítica e novas combinações. *Archivos do Jardim Botânico do Rio de Janeiro* 4: 347–365.
- Kunth, C.S. (1816) In: Humboldt, F.W.H.A., Bonpland, A.J.A. & Kunth, C.S. (eds.), *Voyage de Humboldt et Bonpland. Sixième Partie. Botanique. Nova Genera et Species Plantarum* 1. Ed. Librairie Grecque-Latine-Allemande, Paris, LVIII+377 pp., 96 tab.
- Linnaeus, C. (1759) *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus II. Editio decima, reformata*. Laurentius Salvius, Stockholm, pp. 825–1384.
- McNeill, J., Barrie, F.R., Burdet, H.M., Demoulin, V., Hawksworth, D.L., Marhold, K., Nicolson, D.H., Prado, J., Silva, P.C., Skog, J.E., Wiersema, J.H. & Turland, N.J. (eds.) (2006) *International Code of Botanical Nomenclature (Vienna Code). Regnum Vegetabile* 146. A.R.G. Gantner Verlag KG, Ruggell, 568 pp.
- Missouri Botanical Garden (2012) *Tropicos.org*, Missouri Botanical Garden. Available from: <http://www.tropicos.org/Name/25522634> (Accessed: 21 June 2012).
- Nees von Esenbeck, C.G. (1829) Agrostologia Brasiliensis, seu, Descriptio graminum in imperio Brasiliensi huc usque detectorum. In: Martius, C.F.P. (ed.) *Flora Brasiliensis seu Enumeratio Plantarum* 2(1). J.G. Cotta, Stuttgart and Tübingen, 608 pp.
- Parodi, L.R. (1946) Nuevo género de gramíneas del Brasil. *Boletín de la Sociedad Argentina de Botánica* 1: 293–297.
- Rua, G.H., Speranza, P.R., Arakaki, M. & Vaio, M. (2007) Filogenia del género *Paspalum* (Poaceae, Panicoideae): Análisis preliminares de secuencias de 4 fragmentos del cp-DNA. *Darwiniana* 45(supl.): 120–121.
- Rua, G.H., Speranza, P.R., Arakaki, M. & Vaio, M. (2010) A phylogenetic analysis of the genus *Paspalum* (Poaceae) based on cpDNA and morphology. *Plant Systematics and Evolution* 288: 227–243.
- Scataglini, M.A., Giussani, L.M., Denham, S.S., Zuloaga, F.O. & Morrone, O. (2007) Una aproximación a la filogenia de *Paspalum* (Poaceae, Panicoideae, Paniceae) utilizando tres marcadores de ADN de cloroplasto. *Darwiniana* 45(supl.): 124–125.
- Stafleu, F.A. & Cowan, R.S. (1986) *Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types (TL2)* 6. *Regnum vegetabile*. Scheltema & Holkema, Utrecht & Bohn, 926 pp.
- Trinius, C.B. (1826) *De Graminibus Paniceis. Dissertatio botanica altera*. Impensis Academiae Imperialis Scientiarum, Saint Petersburg, 289 pp.
- Trinius, C.B. (1834) Panicearum genera retractavit speciebusque compluribus illustravit. *Mémoires de l'Académie Impériale des Sciences de Saint-Petersbourg. Sixième Série. Sciences Mathématiques, Physiques et Naturelles. Seconde Partie: Sciences Naturelles* 3(2): 89–346.
- Urban, I. (1893) Biographische Skizzen. *Botanische Jahrbücher* 17: 177–198.
- Urban, I. (1906) Vitae itineraque collectorum botanicorum. In: Urban, I. (ed.), *Flora Brasiliensis* 1(1). Oldenburg, München, pp. 1–154.
- Valls, J.F.M., Boldrini, I.I., Longhi-Wagner, H.M. & Miotto, S.T.S. (2009) O patrimônio florístico dos Campos: potencialidades de uso e a conservação de seus recursos genéticos. In: Pillar, V.P., Müller, S.C., Castilhos, Z.M.S. & Jacques, A.V.A. (eds.), *Campos Sulinos. Conservação e uso sustentável da biodiversidade*. Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Departamento de Conservação da Biodiversidade, Brasília/DF, pp. 139–154.
- Zuloaga, F.O. & Morrone, O. (2003) *Paspalum*. In *Catalogue of New World Grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae. Contributions from the United States National Herbarium* 46: 443–527.
- Zuloaga, F.O. & Morrone, O. (2005) Revisión de las especies de *Paspalum* para América del Sur austral (Argentina, Bolivia, sur del Brasil, Chile, Paraguay y Uruguay). *Monographs in Systematic Botany from the Missouri Botanical Garden* 102: 1–297.