

A NEW VARIETY OF *BROMUS FLEXUOSUS*
(POACEAE: POOIDEAE: BROMEAE: SECT. BROMOPSIS)

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ABSTRACT

Bromus flexuosus was evaluated morphologically using discriminant characters and phenetic cluster analysis. The results support the recognition ***Bromus flexuosus*** var. ***famatinensis*** Planchuelo as a new variety. A morphological description, habitat, geographical distribution, and representative specimens of both varieties of *Bromus flexuosus* are included along with statistical information, a key, synonymies, species descriptions, illustrations, and citations of representative specimens of allied species (*B. lanatus* Kunth and *B. modestus* Renvoize) growing in the Central Andes.

KEY WORDS: *Bromus*, *Bromopsis*, Poaceae, Bromeae, South America

RESUMEN

Bromus flexuosus fue evaluado morfológicamente usando caracteres discriminantes y análisis fenético de agrupamiento. Los resultados soportan el reconocimiento de la nueva variedad ***Bromus flexuosus*** var. ***famatinensis*** Planchuelo. Se presenta la descripción, hábitat, distribución geográfica y especímenes representativos de las dos variedades de *Bromus flexuosus*, junto con datos estadísticos, clave dicotómica, sinonimia, descripciones, ilustraciones y especímenes representativos de las especies afines (*B. lanatus* Kunth y *B. modestus* Renvoize) que crecen en los Andes Centrales.

PALABRAS CLAVES: *Bromus*, *Bromopsis*, Poaceae, Bromeae, Sudamérica

In 1983, Planchuelo described *Bromus flexuosus* as an endemic species for northwestern Argentina. The species seemed unrelated to any other species of section *Bromopsis* Dumort. cited for the country in the available floras (Burkart 1969; Cámara Hernández 1970, 1978). Along with the original description, Planchuelo (1983) separated the specimens into two altitudinal ecotypes, which were identified as Group I and II, leaving the taxonomic status of each Group for future investigation. In the following treatments of *Bromus* for Argentina (Zuloaga et al. 1994; Gutiérrez & Pensiero 1998) and for the Americas (Planchuelo & Peterson 2000; Pavlick et al. 2003), no infraspecific taxa were considered for *B. flexuosus*. More recently, during a revision of *Bromus* toward a preparation of a monograph for South America and with the aim to provide a better understanding of the species of section *Bromopsis* growing in the northwestern Argentina and the Central Andes, current literature and specimens of different herbaria were reviewed. Additional collections of *B. flexuosus* were reported for Peru (Saarela et al. 2006) and for Bolivia (Planchuelo 2010) which expanded the area of distribution of the species northward in the Andes. The affinities (panicles and pedicels flexuosity) and the differences (sizes and pubescence of glumes and lemmas) between *B. flexuosus* and other species of section *Bromopsis* were defined in a partial review of species for the Central Andes (Planchuelo 2009).

In an effort to determine the differences among *B. flexuosus* and related taxa (*B. lanatus* and *B. modestus*) all having a flexuous panicle, a phenetic cluster analysis based on morphological characters, as well as an evaluation of discriminant characters was performed on herbarium specimens.

Based on the cluster analysis and selected discriminant characters, I present evidence for two varieties. A detailed description, habitat information, geographical distribution, representative specimens, and illustration for *B. flexuosus* var. *famatinensis* are provided. Also, taxonomic keys to identify the varieties of *B. flexuosus* and the related taxa are included.

MATERIALS AND METHODS

The morphological data were obtained from herbarium specimens as cited. Vegetative and floral structures were included in the data matrices in order to establish the relationship between the studied materials and the taxa that they represent. The taxa considered were *B. flexuosus*, *B. lanatus*, and *B. modestus*. References for identification are Hitchcock (1927), Planchuelo (1983), Pinto-Escobar (1981, 1986), Matthei (1986), Tovar (1993), Renvoize (1994, 1998), Gutiérrez and Pensiero (1998), and Planchuelo and Peterson (2000). *Bromus pitensis* considered by Planchuelo (1983) as a related species of *B. flexuosus* was not considered in this study because it does not have the typical flexuous pedicels (Planchuelo 2010) and the nodding panicles make the species more related to *B. segetum* Kunth.

Measurements for each variable were taken with the use of 10–15× magnifying lens, and the more frequent value (mode) of that character for each specimen was recorded. Measurements of first and second glumes were recorded independently; however, pubescence of both glumes were considered as only one datum and lemma characters were taken from second lemma only, according to Planchuelo (1991). Leaf distribution on main culm was coded as: 1 = leaves only at the base of the plant; 2 = leaves at the base of the plant and along the culms. Leaf blade pubescence for each surface was divided into three states from 1 to 3: 1 = glabrous; 2 = scattered pubescent along nerves and margins; 3 = scattered to densely pubescent on all surfaces. Pedicel pubescence was divided into three states: 1 = glabrous; 2 = scabrous to scattered pubescent; 3 = densely pubescent to lanate. Glumes pubescence was divided into three states: 1 = glabrous to glabrate; 2 = evenly scattered pubescent; 3 = pubescent all over and dense at the base and margins. Lemma pubescence was scored for three states: 1 = glabrous to glabrate; 2 = scattered pubescent and villous only at the base; 3 = dense pubescent all over and villous at the base and along margins. Maximum and minimum values, as well as mean (μ) and coefficient of variation (CV), expressed in percentage were calculated for all continuous variables. The mode (M) was calculated for discrete variables such, leaf distribution, number of spikelets, florets, and nerves.

The results presented here are based on the analysis of a matrix containing the following 17 morphometric parameters: plant height; leaves disposition in the plant; blade width and pubescence above and below; panicle length and number of spikelets; pedicel pubescence; spikelets length and number of florets; first glumes length, second glumes length; pubescence of glumes, second lemma length, number of nerves, pubescence and awn length. The cluster analysis (Sneath & Sokal 1973) was based on 39 Operational Taxonomic Units (OTU) using Manhattan distance coefficient and the unweighted pair grouping method of arithmetic average (UPGMA) (Michener & Sokal 1957).

Specimens included in the multivariate analysis are identified with the OUT's identification number between brackets (e.g., [10]). Data on geographical distribution, elevation and habitat are based on herbarium specimen labels and personal field observations.

RESULTS AND DISCUSSION

Most of the characters have low (<20% CV) to moderate (<40% CV) variability; except the character "plant height" which CV was over 40% (Table 1). Small plants and narrow blades of *B. flexuosus* are usually associated with specimens collected at high altitude and they are correlated with species habitat as it was reflected by the relatively low CV (less than 20%) found when the statistical analysis was done with selected samples from similar altitudinal range. Panicle length shows very good correlations with plant heights; however, its CV is less than 30% in all three species. The comparison of panicle length, number of spikelets and plant height shows that *Bromus lanatus* and *B. modestus* have lower number of spikelets and much larger plants than *B. flexuosus* given the same length of panicles. These relationship of characters along with large sizes of glumes, lemmas and awns, and the constant number of seven nerves in lemmas present in *B. flexuosus*, are the main discriminant components that separate the three species in two clusters (Fig. 1). *Bromus modestus* is the only species with leaves present only at the base of the plant; therefore, this feature along with the lack of pubescence in pedicels and glumes, are the main discriminant characters between this species and

Table 1. Comparison of Continuous and Discrete Variables indicating: the Minimum (Min) and Maximum (Max) measurement, total number of specimens (n) used in the discrimination analysis; the Mean (μ) for continuous variables; the Mode (M) for discrete variables and the Coefficient of Variation (CV) expressed in percentage.

Characters	<i>B. var. flexuosus</i> n = 11			<i>B. var. famatinensis</i> n = 8			<i>B. lanatus</i> n = 12			<i>B. modestus</i> n = 8		
	Min	Max	μ/M CV	Min	Max	μ/M CV	Min	Max	μ/M CV	Min	Max	μ/M CV
Plant												
Height (cm)	40	70	55.45 17.36	15	50	27.25 43.14	10	30	16.75 44.97	10	35	18.00 45.13
Blade												
Width (mm)	3.5	7.0	4.71 23.81	1.5	4.0	2.88 29.03	1.0	3.5	2.29 34.13	1.0	3.0	1.90 33.29
Panicle												
Length (cm)	13.0	25.0	17.18 26.13	8.0	18.0	13.00 26.96	4.0	11.0	8.04 28.98	3.0	8.0	5.56 18.6
Spikelets												
# Spikelets	8.0	25.0	16 -	8.0	14.0	10 -	4	10	7 -	3	6	5 -
Glumes												
Length (mm)	18.0	24.0	20.27 9.12	16.0	24.0	19.63 13.60	13.0	16.0	13.71 9.64	10.0	15.0	12.31 13.19
# florets	6	8	8 -	5	8	6 -	4	6	5 -	3	6	4 -
1st length (mm)	7.0	9.0	8.11 10.88	8.0	11.0	9.81 16.18	5.0	7.0	5.78 12.77	5.0	7.0	5.78 11.59
2nd length (mm)	8.0	11.0	9.27 10.88	10.0	12.0	10.75 10.17	7.5	8.5	7.80 7.11	7.0	8.0	7.33 4.36
Length (mm)	11.0	13.0	12.12 6.14	11.0	14.0	12.25 8.61	9	11	9.88 7.20	7	9.0	7.93 8.00
# nerves	-	7	7 -	-	7	7 -	5	5	5 -	5	5	5 -
Awn length (mm)	5.0	8.0	6.62 14.6	4.5	7.0	5.54 14.12	3.0	3.5	3.20 7.5	2.0	3.50	2.98 18.12

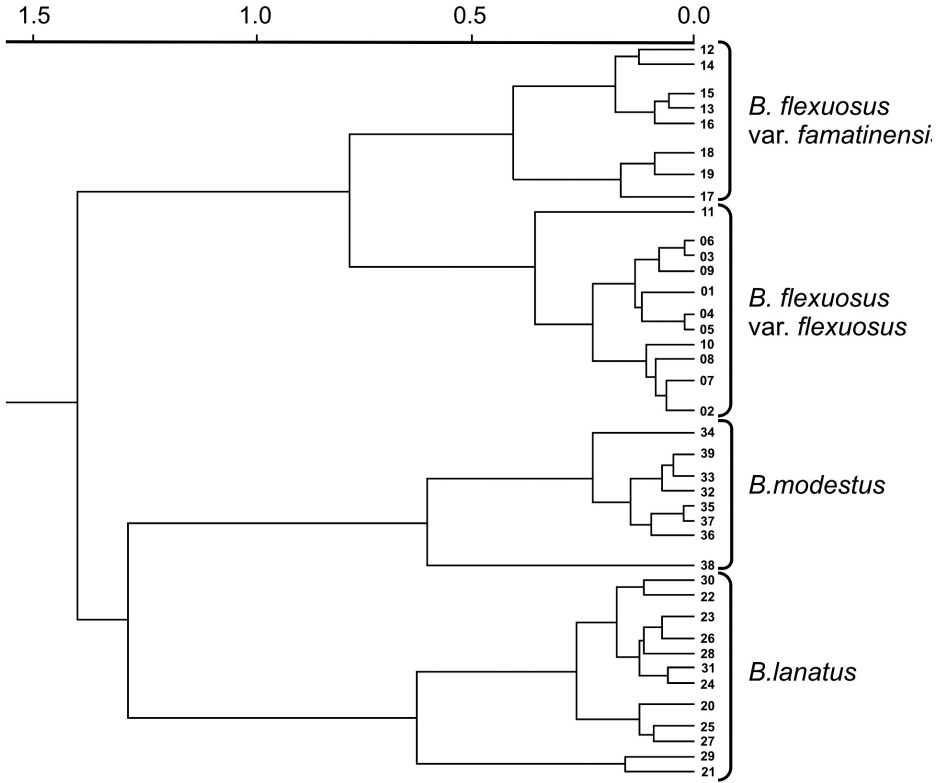


FIG. 1. A UPGMA Phenogram of 39 OTUs based on 17 vegetative and floral characters.

B. lanatus. The differences between varieties of *B. flexuosus* are glumes sizes and pubescence distribution in blades and glumes.

The results shows that, although the taxa have some overlapping in vegetative and floral measurement and in some cases they have similar pubescence characteristics (Table 2), the combination of all the features in the cluster analysis (Fig. 1) clearly separates the 39 analyzed specimens into two main groups. One cluster comprises all representative OTUs of *B. flexuosus* divided into two secondary branches that represent the two varieties; and the other main cluster has two secondary branches that correspond to the specimens identified as *B. lanatus* and *B. modestus*. It is important to point out that in this review the specimen Kurtz 1672a (CORD) cited as *B. flexuosus* in Planchuelo (1983) are now cited as *B. modestus*, species which was not described at the time of the publication of *B. flexuosus*. This new identification approach allowed a better taxa definition, as it is presented in the following taxonomic treatment.

TAXONOMIC TREATMENT

KEY TO THE SPECIES *BROMUS FLEXUOSUS*, *B. LANATUS*, AND *B. MODESTUS*

1. Panicles (8–)10–20(–25) cm with (8–)10–25 spikelets and (5–)6–8 florets; first glumes (7–)8–10 (11) mm long, second glumes (8–)9–11(–12) mm long; lemmas 11–14 mm long, 7-nerved, the awns (4.5–)6–7(–8) mm long _____ **1. *B. flexuosus***
1. Panicles (3–)4–8(–11) cm long with (3–)4–8(–10) spikelets and 3–5(–6) florets; first glumes 5–7 mm long, second glumes 7–8.5 mm long; lemmas 7–10(–11) mm long, 5-nerved, the awn 2–3.50 mm long.
 2. Plants with basal and cauline leaves; pedicels lanate _____ **2. *B. lanatus***
 2. Plants with basal leaves only; pedicels glabrous to scabrous, less frequent scattered pubescent _____ **3. *B. modestus***

TABLE 2. Comparison of Attribute Variables indicating: the number of specimens which have the coded character, from the total number of specimens used in the discriminant analysis.

Characters code numbers	Leaves disposition		Blade pubescence			Blade pubescence above			Pedicels pubescence below			Glumes pubescence			Lemma pubescence			
	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
<i>Bromus flexuosus</i>																		
var. <i>flexuosus</i> n = 11	–	11	–	5	6	5	6	–	–	7	4	–	–	11	–	3	8	
var. <i>famatinensis</i> n = 8	–	8	6	2	–	–	1	7	–	6	2	–	8	–	–	2	6	
<i>Bromus lanatus</i> n = 12	–	12	–	4	8	–	4	8	–	–	12	–	–	12	–	–	12	
<i>Bromus modestus</i> n = 8	8	–	2	4	2	2	4	2	6	2	–	6	2	–	1	7	–	

1. *Bromus flexuosus* Planchuelo, Kurtziana 16:123–131. 1983.

Caespitose perennials. Culms (15–)30–60(–70) cm tall, base covered with loose non fibrous sheaths and leaves. Leaf sheaths retrorse pubescent or scabrous; ligules 1.5–2.5 mm long, laciniate; auricles 1–2 mm long, caducous; blades (10–)20—30(–50) cm long × (1.5–)3.5–6(–7) mm, glabrous, scattered pubescent in nerves to densely pubescent above and below. Panicles (8–)10–20(–25) cm long, open, with (8–)10–25 spikelets, branches and pedicels very flexuous, scabrous, scattered pubescent to lanate. Spikelets (16–)18–20(–24) mm long, with (5–)6–8 florets, slightly imbricate, internodes visible at maturity; glumes narrow-triangular; first glumes (7–)8–10(–11) mm long, 1-nerved; second glumes (8–)9–11(–12) mm long, 3-nerved, mucronate, scattered to pubescent all over and more dense at the base and margins; lemmas 11–14 mm long, ovate, 7-nerved, scattered to densely pubescent all over and villous at the base and margins, awns (4.5–)6–7(–8) mm long. Paleas almost equal to the lemma in length; anthers 0.8–1.2 mm long. Caryopsis 10–11 mm long, widely furrowed not adhering to the palea or lemma.

The two proposed varieties can be easily identified by the following key:

KEY TO THE VARIETIES OF *BROMUS FLEXUOSUS*

1. Blades glabrous or sometimes sparsely pubescent along the nerves and margins above, sparsely to densely pubescent below; panicles 8–13(–18) cm long; glumes evenly scattered pubescent, the first (8–)9–10(–11)mm long, the second 10–11(–12) mm long. ***B. flexuosus* var. *famatinensis***
1. Blades scattered to densely pubescent above, glabrous or sparsely pubescent along the nerves and margins below; panicles (13–)15–25 cm long; glumes pubescent all over and dense at the base and margins, the first 7–8(–9) mm long, the second 8–10(–11) mm. ***B. flexuosus* var. *flexuosus***

Bromus flexuosus Planchuelo var. ***famatinensis*** Planchuelo, var. nov. (**Fig. 2B**). TYPE: ARGENTINA. LA RIOJA. Dpto. Famatina: Sierra de Famatina, La Vega de la Mesada, (28°58'S, 67°47'W) 3650, m 15–16 Mar 1906, Kurtz 13894 (HOLOTYPE: CORD!; ISOTYPE: US!).

Herba perennis, (15–)20–40(–50) cm alta. Lamina 10–15 cm longa, 1.5–4.0 mm lata, pagina adaxialis grabra vel laxa pubescens in margine et nerves, abaxialis pubescens. Panicula laxa flexuosa 8–13(–18) cm longa. Spicula 16–24 mm longa, 5–8-florae. Glumae pubescens, gluma inferiore angusto-triangulata, (8–)9–10(–11)mm longa, 1.5 mm lata, 1-nervata; gluma superiori angusto-ovata, 10–11(–12) mm longa, 2.5 mm lata, 3-nervata. Lemma ovata, 11–14 mm longa, 2.5–2.8 mm lata, 7-nervata, base et marginibus villosis, arista (4.5–)5–6(–7) mm longa.

Etymology.—The epithet “famatinensis” was chosen to reflect the major region of distribution, and specially the place where this new variety grows.

Distribution and Habitat.—Native in the mountains of northwestern Argentina and in the central Andes of Bolivia and Peru. The new variety grows in the same mountain slopes as the typical variety but at altitudes above 3000 m.

Comments.—The specimens *Burkart & Troncoso 11920* and *Parodi 7976* were erroneously cited by Gutiérrez and Pensiero (1998) as *B. lanatus*. The specimen *Kurtz 1672a* (CORD) cited as *B. flexuosus* in Planchuelo (1983) are now cited as *B. modestus*.

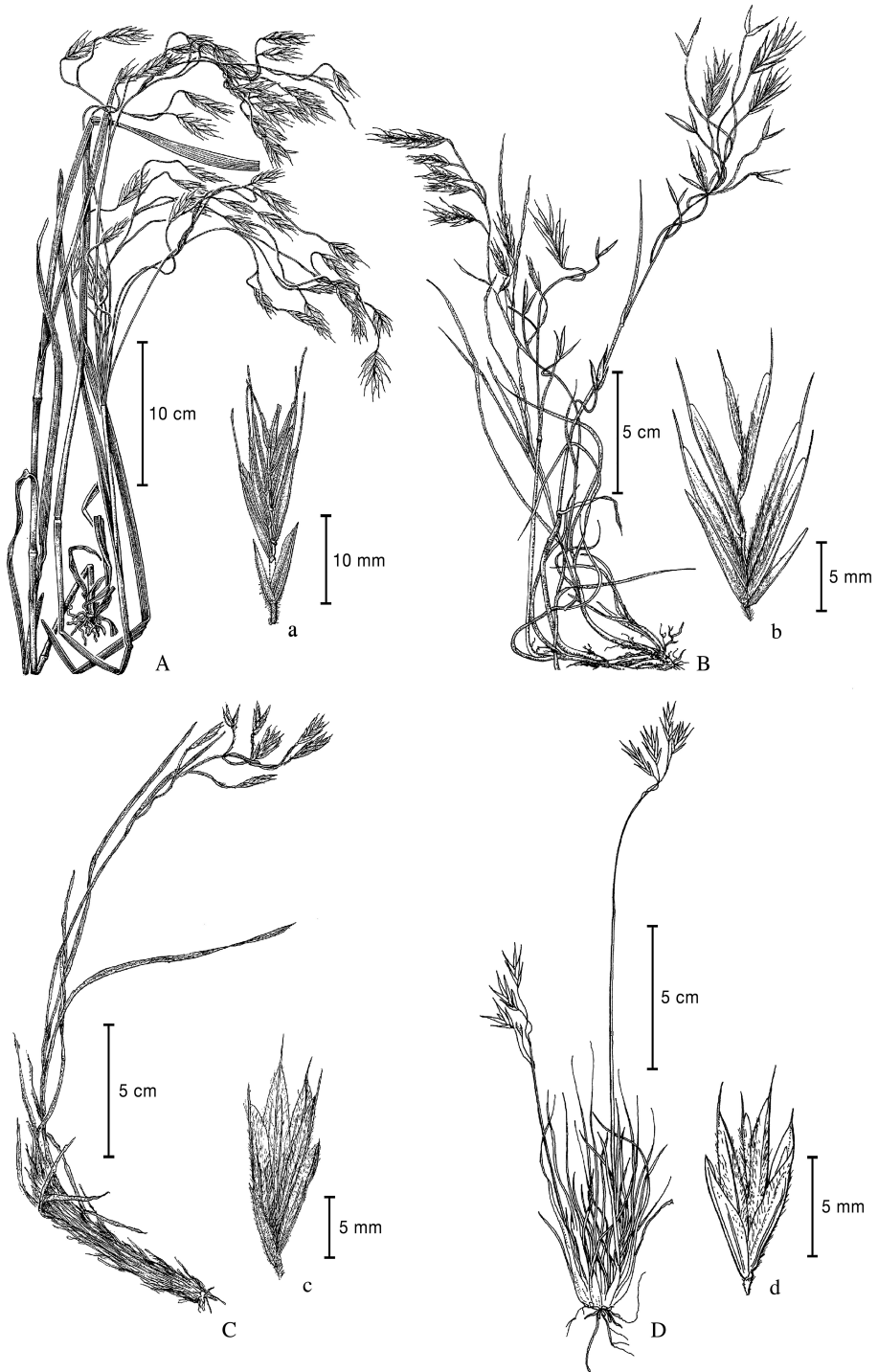


FIG. 2. *Bromus flexuosus* var. *flexuosus*. A. Habit, a. Spikelet (A: *T. Hunziker* 20464, CORD, illustration from Planchuelo 1983 by L. Sánchez); *B. flexuosus* var. *famatinensis*. B. Habit, b. Spikelet (*Kurtz* 13894, CORD, illustration by Planchuelo). *B. lanatus*. C. Habit, c. Spikelet (*Peterson et al.* 14750, ACOR, illustration by Planchuelo); *B. modestus* D. Habit, d. Spikelet (*Peterson et al.* 16215, ACOR, illustration by Planchuelo).

Representative specimens examined. **ARGENTINA. Catamarca:** Dpto. Ambato, subiendo desde El Rodeo hacia el Cerro Manchado, cerca de la Casa de Piedra del Primer Campo, 3500 m, 22 Feb 1971, *AT Hunziker 20989* (CORD). **Jujuy:** Caspala, cerros. 1 Mar 1940. Burkart & Troncoso 11920 (BAA). **La Rioja:** Chilecito: Sierra de Famatina, camino a La Mejicana, estación 6–7, 3800 m, 4 Feb 1927, *Parodi 7976* (BAA, US); En las cercanías de la mina El Oro, 23/25 Jan 1879 *Hieronymus 433* (CORD[17]). Famatina: La vega de La Mesada, ca. 3650 m, 15–16 Mar 1906, *Kurtz 13894* (CORD[12], US); Mina San Juan, 3050–3200 m, 21 Feb 1906 *Kurtz 13602* (CORD[15]); Bajada entre la Cumbre de la Cuesta de La Mesada y La Ciénaga de los Arenales, 3600–3750 m, 21 Mar 1906, *Kurtz 13989* (CORD); Ciénaga de la Calera, 3600–3650 m, 20 Mar 1906, *Kurtz 13937* (CORD[14]); La Mesada, río Amarillo superior. 3500, 25 Mar 1906, *Kurtz 13836 & 13836 bis* (CORD); Las Trancas, Cerro Coloradito, 12 Mar 1907, *leg. R Tejada s/n, Kurtz 14595* (CORD[16]); Real Viejo, 6 Mar 1907, *Kurtz 14758* (CORD); Cueva de Pérez, 26/28 Jan 1879, *Hieronymus et Niederlein 401* (CORD[18]). Dpto. General Sarmiento, El Volcán, 28 Feb 1907, *Kurtz 14642* (CORD); same place, 28 Feb 1907, *Kurtz 14650* (CORD[13]); Las Cortaderas, entre El Peñón y El Jagüel, 27 Feb 1879, *Hieronymus 245* (CORD[19]). **BOLIVIA. Cochabamba:** Arque, Cerca camino a San Miguel, quebrada Sikipampa, 4000 m, 2 Jan 1992, *no collector, no number* (BOLV); Quillacollo, Town of Tiquipaya, Valley above the Taquiña brewery, 2840 m, 23 Mar 1994, *Ritter 666*, (BOLV); Quillacollo, bosque de *Polylepis* camino Sipe Sipe, Lipichi, 3800 msm, 24 May 1990, *I. Hense 697* (BOLV). **PERU. Ancash:** Huaylas, Huascarán National Park, Quebrada Llaca, NW side of valley 77° 27' W, 9° 27' S, 4400–4600 m, 24 May 1985, *D. Smith et al. 10837* (MO); Quebrada Santa Cruz at base of an entering Quebrada Artizonraju, 77° 36' W, 8° 55' S, 4300–4800 m, 16 Jan 1985, *D. Smith et al. 9303* (MO). **Puno:** Cerro El Calvario, 4000 m, 25 Feb 1965, *A. Arevalo 135* (LIL).

***Bromus flexuosus* Planchuelo var. *flexuosus* (Fig. 2A).** TYPE: ARGENTINA. CATAMARCA: Pomán, subiendo desde El Rincón rumbo al Cerro Manchado, más arriba de Las Casitas, 2500–2750 m, 19 Feb 1970, *AT Hunziker 20464 A&B* (HOLOTYPE: CORD!; ISOTYPE: US-26690221).

Distribution and Habitat.—Native in Northwestern Argentina and in the Central Andes region of Bolivia and Peru. It grows in grassland and mountain slopes above 2000 m.

Major references.—Planchuelo (1983); Zuloaga et al. (1994); Gutiérrez and Pensiero (1998); Planchuelo and Peterson (2000); Pavlick et al (2003).

Comments.—The specimen *Peterson & Refulio-Rodriguez 16556* (ACOR, US, USM) was cited for Peru in Saarela et al. (2006) and was the first record of *B. flexuosus* beyond northwestern Argentina where it was originally described.

Representative specimens examined: **ARGENTINA. Catamarca:** Ambato, Sierra de Ambato, (Falda E), Subiendo desde El Rodeo hacia el Cerro Manchado, ca. 2900/3100 m, 23/25 Feb 1967, *AT Hunziker 19209* (CORD[07]); Alrededores de Los Cajones, ca 3000 m, 28/30 Jan 1968, *AT Hunziker & Di Fulvio 19709* (CORD[04]). Andalgalá/Pomán, En el altivalle de Las Granadillas, cerca de Belén, 1 Feb 1872, *Lorentz s/n*, (CORD[09]); Pomán, subiendo desde El Rincón rumbo al Cerro Manchado, más arriba de Las Casitas, 2500–2750 m, 19 Feb 1970, *AT Hunziker 20464A,B,C* (CORD[A01] US); Alrededores de Las Casitas, frente a El Rincón, ca. 2500 m 20 Feb 1970, *AT Hunziker & Ariza 20397* (CORD[05], US). **La Rioja:** Chilecito, camino a La Mexicana, estación 6, 3300 m, 5 Feb 1927, *Parodi 7963* (BAA). Famatina, entre Totoral y Ojo de Agua Superior, 3000 m, 20/21 Mar 1906, *Kurtz 13500* (CORD[11], US); En las cercanías del pie de la cuesta, más arriba del vallecito, 15/20 Jan 1879, *Hieronymus & Niederlein 663* (CORD). Famatina/Chilecito, ca. 2500 m, 21 Jan 1908, *Kurtz 14978* (CORD[08]); La Hoyada, arriba de Vallecito, ca. 2500 m, 22/24 Jan 1908, *Kurtz 14985A,B* (CORD[A03]); same place, in campo castra raro, 22/24 Jan 1908, *Kurtz 14983* (CORD); same place, 31 Jan 1908, *Kurtz 15029* (CORD); Arriba de Vallecito, 2500 m, 3 Feb 1908, *Kurtz 15058* (CORD[10]); La vega de La Hoyada, ca. 2700–2800 m, 17/22 Jan 1908, *Kurtz 15128A, B* (CORD[A06]); same place, 18 Jan 1908, *Leg. J. Jimenez, Kurtz 15138* (CORD). **Tucumán:** Peñas Azules, 3500 m entre San Javier y Amaicha. 27 Jan 1933, *Parodi 10953* (BAA); La Puerta 4000 m, 28 Jan 1933. *Parodi 10893* (BAA). Chicligasta, estancia Las Pavas, 3200 m, 13 Mar 1924, *Venturi 3150* (LIL, US); Puesto La Cascada 2700 m, 13 Mar 1924, *Venturi 3137* (LIL, US). **Salta:** Camino a cuesta del Arca-Trancas. Dec 1896, *Spegazzini 2558* (BAA plants B,C only). **BOLIVIA. Cochabamba:** Cervecería Taquiña. 2570 m, May 1944, *M. Cardenas 3450* (BAA); Quillacollo, Town of Tiquipaya, Valley above the Taquiña brewery, 2840 m, 23 Mar 1994, *Ritter 666* (BOLV). **PERU. Cuzco:** Calca, 22 km N of Calca on road towards Lares, 4120 m, 13°12'56.6"S 71°54'35.2"W, 16 Mar 202, *Peterson & Refulio-Rodriguez 16556* (ACOR[02], US). La Libertad, Hamachuco, Cachipampa, 3150 m, 12 Feb 1948, *Infantes Vera 1968* (BAA). **Junín:** Laguna Tuctuca entre Runotullo y Carrizal, 4200 m, 30 Jan 1953, *C Ochoa 2015* (BAA).

***Bromus lanatus* Kunth, Nov. Gen. Sp. Pl. 1:150. 1816. (Fig. 2C).** *Schenodorus lanatus* (Kunth) Roem. & Schult., Syst. Veg. 2:708. 1817. TYPE: ECUADOR. PICHINCHA/NAPO: Crescit on dexvixis montis ignivomi Antisanæ, *Bonpland s.n.* (HOLOTYPE: P; ISOTYPES BM; photo K!, US-865493 fragm!).

Bromus oliganthus Pilg., Bot. Jahrb. Syst. 25:718. 1898. TYPE PROTOLOGUE: ECUADOR. IMBABURA: Páramo de Pirán, 4400 msm, *Stübel 61H* (LECTOTYPE, designated here: US-00131962!; ISOLECTOTYPE: US-00081611!), ECUADOR. In paramos montis ignivomi Antisana ad Cerro de la Media Luna, alt. 4400 m, *Stübel 230a* (SYNTYPE: B), ECUADOR. Pichincha. *Stübel 20c* (SYNTYPE: B); ECUADOR. In monte ignivomi Puntas, alt. 4400 m, *Stübel 207a* (SYNTYPE: B). COLOMBIA. Crescit in monte Tolima ad Boca del Monte, *Stübel 202* (SYNTYPE: US)

Perennial. Culms (10)–15–20(–30) cm tall. Leaf sheaths close and retrorsus pubescent to the apex, ligules

membranous glabrous, apex dentate; blades 4–8 cm × 1–3.5 mm, scattered to densely pubescent above and below with long hairs at the margins. Panicles (4–)6–8(–11) cm long, with (4–)5–8(–10) spikelets, branches flexuous shorter towards the apex, pedicels lanate and flexuous. Spikelets 13–16 mm long, 4–5(–6)-florets not imbricates with rachilla visible; glumes lance-attenuate, pubescent throughout, densely so near base and margins, first glumes 5–7 mm long, 1-nerved, second glumes 7.5–8.5 mm long, 3-nerved; lemmas 9–11 mm long, oval-lanceolate, 5-nerved, densely pubescent and villous at the base and margins, awns 3–3.5 mm long, subapical. Paleas a little shorter than the lemma; anthers 0.5–0.8 mm long. Caryopsis 6 mm long, widely furrowed, not attached to the lemma and palea.

Distribution and Habitat.—Native to the central Andes. Commonly occurs in grass paramos (treeless alpine plateau, neo-tropical ecosystems) on sandy to rocky slopes and humid places above 2000 m; found in northern Argentina and Chile and especially in Bolivia, Peru, and Ecuador.

Major references.—Standley (1947), Pinto-Escobar (1981, 1986), Matthei (1986), Tovar (1993), Gutierrez and Pensiero (1998), Renvoize (1998), Planchuelo and Peterson (2000).

Comments.—I agree with the original description of Kunth (1816) and with Matthei (1986) that *B. lanatus* has lemmas with five nerves. The observation “lemma 7-nervada” from dry fragments (isotype) of *B. lanatus* by Planchuelo (1983) is erroneous because what was thought to be the two laterals emerging and inconspicuous nerves were the marked crest of the folded lemma base, revealed only after hydrating the materials. The specimen *Spegazzini* 2558 from the herbarium BAA has five plants and two panicles mounted in the same sheet. The plant mounted at the left bottom corner, assigned to the letter A is *B. lanatus*, all other plants and panicles correspond to *B. flexuosus* var. *flexuosus*. This important finding indicates that both species share the same habitat in Salta, Argentina. Unfortunately, that region is not well explored and no new specimens have been collected. A similar case of both species sharing the same habitat is seen in three collections of the BAA herbarium by Parodi in “La Rioja, Famatina, Camino a La Mexicana” where the specimen numbered *Parodi* 7919 is *B. lanatus*, the specimen *Parodi* 7963 is *B. flexuosus* var. *flexuosus* and *Parodi* 7976 is *B. flexuosus* var. *famatinsensis*.

Representative specimens examined: **ARGENTINA. Jujuy:** Yavi, Cerro Negro 5000 m 1 Apr 1940, *Meyer & Bianchi* 14921 (BAA[22]); Tres cruces, camino a pie del puente del Diablo 3700 m, 20 Feb 1959, *Fabris & Marchionni* 1791 (BAA[25]). **La Rioja:** Famatina. Camino a La Mexicana, estación 4, 2500 m, 5 Feb 1927, *Parodi* 7919 (BAA[23]). **Salta:** Camino a cuesta del Arca-Trancas. Dec 1896, *Spegazzini* 2558 (BAA plant A only[26]). **BOLIVIA. La Paz:** Chinchaya, 11 Jun 1959, *Giménez* 82 (BAA[24]). Murillo: Valle del Río Zongo, 11 km al norte de la cumbre, puna húmeda 16°13'S, 58°07'W 4100 m, 8 Mar 1987, *Solomon* 16302 (BOLV, MO); 14.8 km al N de la cumbre, valle lateral arriba de Laguna Viscachani, 16°12'S, 68°07'W 3900–4000 m, *Solomon et al.* 16526, 11 Abr 1987 (MO[27]); 1 km al N (abajo) de la represa del Lago Zongo, 16°17'S 68°07'W 4600 m, 21 Jan 1987, *Solomon* 15821 (BOLV, MO[28]); Ca. 1 km NW of Ovejuyo, 16°32'S, 68°03'W, 3700–3900 m, 2 Apr 1982, *Solomon* 7438 (MO[31]). **CHILE. Region I:** 106 km NE of Huará on road towards Colchane, 4340 m, 19°34'53.2"S, 68°58'01.1"W, 26 Mar 2001, *Peterson & Soreng* 15651 (MO); 4 km N of Termas Chirigualla SW of Chungará 4720 m, 18°19'42.9"S, 69°08'51.7"W, 4 Apr 2001, *Peterson & Soreng* 15760 (MO). **ECUADOR. Azuay:** Páramo de las Cajas, W of Cuenca, 79°14'W, 2°47'S, 4000–4150 m, 2 Sep 1984, *Laegaard* 52841 (QCA); Laguna Suorococha, 35 km on Cuenca-Molleturo road, 79°14'W, 2°48'S, 4200–4400 m, 30 Jan 1988, *Eriksen* 2796 (QCA). **Bolivar/Chimborazo:** On road Guaranda/Riobamba, NE of road, 78°50'W, 01°35'S, 4050–4150 m, 10 Jul 1990, *Laegaard* 71743 (QCA). **Chimborazo:** Arenal du Chimborazo 4800 m, 13 Nov 1988, *Huttel* 370 (QCA); surroundings of refugio Whymper, 78°50'W, 01°29'S, 4770–4850 m, 3 Mar 1992, *Laegaard* 101571 (QCA). **Cotopaxi:** Volcán Cotopaxi. Along the road to and at Limpio Punga, 78°27'W, 0°37'S, 3500–3850 m, 23 Mar 1984, *Laegaard* 51861 (QCA); W side of volcán Cotopaxi, above Rancho Santa María, 78°29'W, 00°43'S, 3750–3950 m, 27 May 1984, *Laegaard* 52203 (QCA); 9 km SW of El Chaupí, on road to base of Illinizas, 4200 m, 1 May 1990, *Peterson & CR Annable* 8959 (QCA, US); Latacunga-Quevedo road, ca. 28.5 km W of Latacunga, Ca 0°52'S, 78°43'W, 3780 m, 4 April 1992, *Lutayn & Quezada* 14391 (MO[30], NY). **Imbabura:** South Western slopes of volcán Cotacachi, 78°21'W, 00°22'S, 4100–4320 m, 9 Nov 1983, *Boysen Larsen et al.* 45638 (QCA). **Pichincha:** Reserva Geobotánica Paschoa, 78°29'W, 00°21'S, 3100–3400 m, 23 Feb 1992, *Laegaard* 101409 (QCA); Carretera Pifo-Papallacta, 3 km al oriente de la Ha. Paluquillo, 78°17'W, 00°16'S, 3000 m, 12 Feb 1999, *Terneus & Laegaard* 364 (QCA); Highway Quito to Baeza, Papallacta, paramo 3945 m, 1 Dec 1976, *JD Boeke* 452 (QCA); Paramo Guamani, W slopes along Quito, Baeza road, 3800–4100 m 0°18'S, 78°14'W, 17 Jan 1981, *Balslev* 1609 (QCA). **Pichincha/Napo:** Volcán Antisana, between campamento IMAP, laguna Micacocha, 78°12'W, 00°33'S, 3850–3950 m, 7 Mar 1992, *Laegaard* 101608 (QCA); base del volcán Antisana, entrada por Pintag hacia laguna Micacocha, 78°10'W, 00°30'S, 4250 m, 7 Oct 1990 (QCA). **Tungurahua:** Along trail Mesa Tablon to Limpiopungus, S of Lag. Pisayambo, 78°21'W, 01°07'S, 4150–4250 m, 14 Jan 1999, *Laegaard* 19467 (QCA); Santiago de Pillaro, Parque Nacional Llanganates, camino desde el Páramo de Soguillas hasta Aucacocha, 01°08'S, 78°19'W 3940 m, 16 Nov 1999, *Narváez et al.* 540 (MO). **PERU. Cajamarca:** Cajamarca-Bambamarca road, in puna 78°33'W, 7°00'S,

3800 m, Rageland, Jalca areas of saturated soil, 17 Feb 1983, *Smith & Vasquez* 3483 (MO[29]); 52 km N of Cajamarca on HWY 3, N towards Bambamarca, 3700 m, 16 Mar 2000, *Peterson & Refulio-Rodriguez* 14908 (MO). **Cuzco:** Paucartambo, 21 km NE of Paucartambo on road to Tres Cruces, 3460 m, 13°11'54.8"S, 71°38'40.5"W, 18 Mar 2002, *Peterson & Refulio-Rodriguez* 16622 (ACOR [20], US). **Tacna:** 7 km NW of Alto Perú on Río Uchusuma, 4330 m, 13 Mar 1999, *Peterson, Refulio Rodriguez & Salvador Perez* 14750 (ACOR[21], US).

Bromus modestus Renvoize, *Kew Bull.* 49:543–546. 1994. (**Fig. 2D**). *Bromus frigidus* Ball, *J. Linn. Soc., Bot.* 22:63. 1885, *hom. Illeg.* TYPE: PERU: Lima, above Casapalta, *Ball* s.n. (HOLOTYPE: K!; ISOTYPE: US-2858545 frag, ex K!).

Perennial caespitose with the base covered with loose non fibrous sheaths. Culms 10–35 cm tall, with leaves only at the base of the plant. Sheaths often open at middle way, retrorse pilose to sericeous, ligules membranous, glabrous, 1 mm long, apex lacinate. Auricles absent. Blades 3.5–11 cm long × 1–3 mm folder or plane, glabrous, glabrate or scattered to densely pubescent along nerves and margins on both sides. Panicles lax, 3–8 cm long, branches short and flexuosus, with 3–6 spikelets, pedicels flexuosus, glabrous to scabrous, less frequent scattered pubescent. Spikelets 10–15 mm long 3–4(–6)-florets, imbricate. Glumes glabrous, glabrate to scattered pubescent, the first narrowly-triangular 5–7 mm long, 1-nerved, the second lanceolate 7–8 mm long, 3-nerved. Lemma lanceolate, 7–9 mm long, 5-nerved, glabrous or glabrate to scattered pubescent all over and villous only at the base, apex acute; awn subapical, straight 2–3.5 mm long; Palea 6–8 mm long with long hairs on the nerves. Anthers 1 mm long. Caryopsis 6–8 mm long narrowly furrowed attached to the lemma and palea.

Distribution and Habitat.—Native in the Andes, from northern Chile and Argentina northward to Ecuador and Colombia. Grows on mountain slopes and high plains, between 3600–4700 m.

Major references.—Renvoize (1994, 1998); Planchuelo & Peterson (2000).

Comments.—Renvoize (1994) described *B. modestus* by giving a new name to *B. frigidus* Ball. Some authors (Pinto Escobar 1981 and Tovar 1993) considered *B. frigidus* as synonym of *B. pitensis*. Saarela et al. (2007) demonstrated that *B. modestus* and *B. lanatus* formed an exclusive clade in a plastid tree, based on chloroplast and nuclear DNA sequence data, which reaffirms the affinities of both species established by the morphological analysis in this paper. The specimens, *Weberbauer* 6902 (US) and *leg. Harlan*, US 727045 (US), were cited as *B. lanatus* by Standley (1947), the specimen *Parodi* 10854 (BAA, US) was also cited as *B. lanatus* by Gutiérrez & Pensiero (1998) and the specimen Kurtz 1672a (CORD) was cited as *B. flexuosus* in Planchuelo (1983).

Representative specimens examined: **ARGENTINA. Jujuy:** Cochinoca, Laguna Tres Cruces, 14 Feb 1901, *Leg. Claren*, Kurtz 1672a; Kurtz 11692 (CORD[35]). **Salta:** Santa Victoria, Abra de Lizoite, 22°13'S, 65°13'W, 4450–4590 m, 8 Mar 2002, *Negrilo et al.* 408 (CORD[36]). **Tucumán:** Tafí, El Molle, en el camino entre Tafí del Valle y Amaicha, km 91/92, 2800/2900 m, 12 Feb 1986, *AT Hunziker et al.* 24893 (CORD[37]); Región montañosa entre San Javier y Amaicha, 4200 m, 30 Jan 1933, *Parodi* 10854 (BAA[38], US). **BOLIVIA. La Paz:** Murillo, Valle del Río Zongo, 14.8 km al N de la cumbre, valle lateral arriba de Laguna Viscachani, 16°12'S, 68°07'W 3900–4000 m, 11 Apr 1987, *Solomon et al.* 16526 (MO[39]). **COLOMBIA. Caldas:** Cordillera Central, Páramo de Las Letras, ca 370 m, 4 Dec 1958, *Barclay & Juajibioy* 6261 (MO). **PERU. Apurímac:** Aymaraes, 22 km NE of Chalhuanca on road towards Yanaca, 4000 m, 14°16'19.8"S, 73°13'07.2"W, 13 Mar 2002, *Peterson & Refulio Rodriguez* 16499 (ACOR[32], US). Arequipa: Sumbay, 4000 m, 1909–1914, *Weberbauer* 6902 (US). **Ayacucho:** Lucana, 2 km SW of Putajasa. 3900 m, 14°08'15.9"S, 74°11'18.4"W, 24 Feb 2002, *Peterson et al.* 16215 (ACOR[33], US); between Huanta and Hacienda Pargora, 4000 m, 2/4 May 1929, *Killip & Smith* 23310 (US). **Lagunillas:** Mountain crest, 14600 ft, 16 Feb 1914, *leg. Harlan*, US 727045 (US). **Puno:** Chucuito, 20 km E of Huacullani on road towards Desaguadero, 3880 m, 5 Mar 1999, *Peterson, Refulio Rodriguez & Salvador Perez* 14636 (ACOR[34], US).

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