

## The nomenclature of *Sorghum bicolor* (L.) Moench (*Gramineae*)

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The currently used subspecific names for the annual wild and weedy relatives of domesticated sorghum either lack valid publication or have not had their priority established over competing names of equivalent priority. These problems are resolved with valid publication of the new combination *Sorghum bicolor* subsp. *verticilliflorum* and establishment of its priority and that of *S. bicolor* subsp. *drummondii* over competing synonyms.

**KEYWORDS:** milo, new combination, Poaceae, *Sorghum*, sorgo, validation

### INTRODUCTION

According to FAO, sorghum ranks fifth in world grain production behind wheat, rice, maize, and barley (FAOSTAT 2005). The classification of domesticated sorghum and its wild and weedy relatives, a complex comprising all annual members of *Sorghum* Moench subg. *Sorghum*, has been quite controversial owing to extensive variability within the group. The comprehensive treatment of this complex by Snowden (1936) defined 7 weedy, 13 wild, and 28 cultivated species and numerous varieties and forms from within this variability. A refinement of Snowden's classification was developed by Jakuševskij (1969), and is still used in some parts of the world (Fritsch, & al. 2001), especially those of the former Soviet Union. Difficulties in applying the complicated Snowden classification and the lack of genetic barriers between these taxa however led de Wet & Huckabay (1967) to treat all of *S. subg. Sorghum*, including the perennial members, within a single species, *S. bicolor* (L.) Moench.

De Wet & Huckabay's (1967) classification of *S. bicolor* separated the perennial plants as "*S. bicolor* subsp. *halepense*". In failing to provide a full and direct reference to the presumed basionym, *Holcus halepensis* L., they did not validly publish this subspecific name either under Art. 33 of the *International Code of Botanical Nomenclature (Edinburgh Code)* then in effect (Lanjouw & al., 1966) or under Art. 33.4 of the current *Vienna Code* (McNeill & al. 2006). Since the plants involved are now generally treated at specific rank, this is of little consequence and requires no further discussion. At that time the annual plants of this complex were combined into *S. bicolor* subsp. *bicolor*, treating the cultivated members as *S. bicolor* var. *bicolor* and partitioning the wild and weedy relatives into three varieties, *S. bicolor* vars. "*arundinaceum*", "*aethiopicum*", and "*verticilliflorum*". For the same reason as before, these

varietal names were also not validly published. To these three varieties, assumed to have been established by de Wet & Huckabay (1967), was added a fourth, "*S. bicolor* var. *virgatum* (Hack.) de Wet & Harlan comb. nov.", by de Wet & al. (1970), but although they provided a full reference to "*S. virgatum* (Hack.) Stapf" this combination, not meeting the conditions of current Art. 33, was also not validly published. All four varietal names continued to be accepted by de Wet & Harlan (1971), who were obviously unaware of the status of these names.

Meanwhile, sorghum breeders have evolved an elaborate and partially overlapping classification of the cultivated crop and its relatives. These were initially divided into ca. 70 working groups by Murty & al. (1967), largely based on the Snowden classification, and later Harlan & de Wet (1972) proposed an alternative system recognizing among the cultivated sorghums five basic races and ten intermediate races, the latter resulting from combinations of the basic races, and six spontaneous races for the wild and weedy forms. Both the numbered working group categories and their corresponding race designations have achieved standardized usage among agricultural workers, especially with regard to domesticated sorghum (generally regarded as *S. bicolor* subsp. *bicolor*), so much so that Dahlberg (2000) has now developed a new integrated classification scheme which incorporates both the "working groups" and the "races" from these prior classifications.

### CURRENT NOMENCLATURE OF WILD AND WEEDY SORGHUM RELATIVES

The wild and weedy relatives of cultivated sorghum, while accommodated within the "race" or "working group" classification of sorghum breeders, have continued

to be associated with their corresponding botanical names. For the wild types, Murty & al. (1967) listed nine species as working groups among the “Para Sorghums”. Although de Wet & al. (1970) had grouped these same elements (the so-called Spontanea complex) into the four varieties mentioned previously, these were later considered races of “*S. bicolor* subsp. *arundinaceum* (Desv.) de Wet & Harlan” by de Wet (1978), using a combination said to have been published in de Wet & al. (1976), although not validly so. Even though de Wet (1978) provided a full reference to “*S. arundinaceum* (Desv.) Stapf” this combination, again not meeting the conditions of Art. 33, was not validly published. At the same time de Wet (1978) grouped the weedy sorghums, resulting from hybridization between the cultivated and wild types, under the name “*S. bicolor* subsp. *drummondii* (Steud.) de Wet, comb. nov. Based on *S. drummondii* (Steud.) Millsp. et Chase”; this is not a validly published name for the same reason as before.

While treatment of these domesticated, weedy, and wild sorghums at species rank, under the names *S. bicolor*, *S. ×drummondii*, and *S. arundinaceum*, is quite common in taxonomic works (e.g., Clayton & Renvoize, 1982; Cope, 1982; Mill, 1985; Setshogo, 2002), de Wet’s (1978) classification of these same three entities together in a single biological species is today generally accepted among sorghum breeders (Doggett, 1988; Dahlberg, 2000) and by some taxonomists (e.g., Gibbs Russell & al., 1991; Barkworth, 2003). Aware of the nomenclatural problems surrounding de Wet’s subspecific combinations, Davidse (1993) validly published both *S. bicolor* subsp. *arundinaceum* (Desv.) de Wet & Harlan ex Davidse and *S. bicolor* subsp. *drummondii* (Steud.) de Wet ex Davidse. By then, however, de Wet & Prasada Rao (1986?), in a circulated 1986 symposium paper of doubtful publication, had already determined that *S. bicolor* subsp. *arundinaceum* was “taxonomically invalid” and suggested “subsp. *verticilliflorum* (Steud.) de Wet comb. nov.” to replace it. Since a basionym was not indicated, *S. bicolor* subsp. *verticilliflorum* would not have been validly published, and although it has appeared in several agriculture publications since (e.g., Doggett, 1988; Stenhouse & Tippayaruk, 1996; Dahlberg, 1995, 2000), it still lacks valid publication.

**Subspecific name for wild sorghums.** — What motivated de Wet & Prasada Rao (1986) to take up *S. bicolor* subsp. *verticilliflorum* may have been their realization that the earlier choice of the epithet “*arundinaceum*” was based on its priority at species rank and that a name cannot “have priority outside the rank in which it is published” (Art. 11.2) and some awareness that Piper (1915) had much earlier used the epithet “*verticilliflorum*” at subspecific rank. Although this is nowhere apparent in their 1986 paper, such a connection is suggested by Doggett a few years later (1988) in adopting de Wet’s combination by his citation (p. 22) of “*Sorghum bicolor* subsp. *verticilliflorum*

(Steud.) Piper”. But Piper (1915) had validly published this as “*Andropogon sorghum verticilliflorus* (Steudel) n. comb.”, based on *A. verticilliflorus* Steud. While using the terms “races” and “subspecies” interchangeably in his comments under *A. sorghum* (L.) Brot., Piper provided a key to eleven “wild subspecies”, labelled all six of his new taxa with “n. subsp.”, and used only “subspecies” in his discussion under each one, so it is clear from the context that subspecies was the intended rank.

To date, no one adopting de Wet’s nomenclature seems to have noticed that Piper had simultaneously established ten other subspecies of *A. sorghum* in addition to subsp. *verticilliflorus*. Included among these were (1) *A. sorghum* subsp. *vogelianus* Piper, for which de Wet (1978) had cited the homotypic synonym *S. vogelianum* (Piper) Stapf under his “subsp. *arundinaceum*”; (2) *A. sorghum* subsp. *effusus* Piper, lectotypified by Piper on the type of *Rhaphis arundinacea* Desv., the supposed basis for de Wet’s “subsp. *arundinaceum*”; and (3) *A. sorghum* subsp. *abyssinicus* Piper, which Snowden (1936) renamed as *S. macrochaeta* Snowden, a name cited by de Wet under “subsp. *arundinaceum*”. Also included among his “wild subspecies” was (4) *A. sorghum* subsp. *eichingeri* Piper (“*eichengeri*”). This was placed next to *A. sorghum* subsp. *exiguus* sensu Piper (see below), for which Piper had wrongly applied the epithet “*exiguus*” to Hackel’s (1889) *A. sorghum* var. *virgatus*, a taxon synonymized by de Wet (1978, “as *S. virgatum* (Hack.) Stapf”) under “subsp. *arundinaceum*”. In listing it among his “imperfectly known species and varieties”, Stapf (1917, as “var. *eichingeri*”) compared it to *S. aethiopicum* (Hack.) Rupr. ex Stapf, another synonym placed under “subsp. *arundinaceum*” by de Wet (1978). The type of this name, *Eichinger* 3365 from Tanzania (B), was not studied by Stapf (1917) or Snowden (1936) and may no longer be extant. The four names involved, together with (5) *A. sorghum* subsp. *verticilliflorus*, all have equivalent priority and, being the earliest available names at subspecies rank, any one of these could potentially furnish the correct epithet for a subspecies of *S. bicolor* equivalent to “subsp. *arundinaceum*”, an epithet having priority at this rank only from 1993 that cannot be correctly applied to this subspecies. A choice between these names has yet to be made under Art. 11.5, which requires the acceptance of one name and simultaneous rejection of the others. Such a choice is accomplished below, together with the valid publication of *S. bicolor* subsp. *verticilliflorum*.

The basionym for this subspecies name, *A. verticilliflorus* Steud., traces to a collection from Réunion apparently not seen by either Piper (1915) or Snowden (1936), neither of whom visited the herbarium in Paris, where Steudel’s private herbarium now resides (Stafleu & Cowan, 1985). Piper’s application of the name to a wild race of cultivated sorghum was drawn from study

of several other specimens from the Mascarenes and other Indian Ocean islands and from eastern Africa, and matches the concept employed by both Stapf (1917) and Snowden (1936).

**Subspecific name for weedy sorghums.** — We now return to a discussion of de Wet's (1978) other subspecies, "*drummondii*". As already mentioned, this was later validly published by Davidse (1993), who, however, failed to take account of the earlier names of Piper (1915). As it turns out, Piper had published at least four subspecies that should have been considered. These include (1) *A. sorghum* subsp. *sudanensis* Piper, (2) *A. sorghum* subsp. *hewisonii* Piper, and (3) *A. sorghum* subsp. *niloticus* Stapf ex Piper, for which de Wet had cited the homotypic synonyms *S. sudanense* (Piper) Stapf, *S. hewisonii* (Piper) Longley, and *S. niloticum* (Stapf ex Piper) Snowden under his "subsp. *drummondii*", and (4) *A. sorghum* subsp. *drummondii* (Steud.) Piper, which is homotypic with Davidse's *S. bicolor* subsp. *drummondii*. Again, there are names of equivalent priority, any of which could potentially furnish the correct epithet for a subspecies of *S. bicolor* taxonomically equivalent to subsp. *drummondii*. While the latter epithet has already been transferred to *S. bicolor*, its priority over the others has not been established, so adoption of any one of these other epithets under this species, with simultaneous rejection of the rest, including *S. bicolor* subsp. *drummondii*, would result in a new correct subspecies name. To allow continued use of the name established by Davidse, an effective choice under Art. 11.5 is accomplished below.

**Other inapplicable subspecific names.** — It may be useful to account for the two other subspecies of *Andropogon sorghum* of Piper (1915). One is *A. sorghum* subsp. *exiguus* (Forssk.) Piper, applied by Piper to the cultivated "Tunis grass", otherwise known as *A. sorghum* var. *virgatus* Hack. or *S. virgatum* (Hack.) Stapf, the latter name synonymized by de Wet (1978) under "subsp. *arundinaceum*". However, since Piper explicitly based his name on *Holcus exiguus* Forssk., a name that, according to both Stapf (1917) and Hepper & Friis (1994), applies to *S. halepense* (L.) Pers., this subspecies can be eliminated from consideration. The other is *A. sorghum* subsp. *cordofanus* (Hochst.) Piper, which Piper had applied to *A. sorghum* var. *aethiopicus* Hack., basionym of *S. aethiopicum* (Hack.) Rupr. ex Stapf, a name also synonymized by de Wet (1978) under "subsp. *arundinaceum*". However, since Piper had explicitly based his subspecies on *Andropogon cordofanus* Hochst., which, according to both Stapf (1917) and Snowden (1936) is a true *Andropogon*, not a *Sorghum*, this name can also be ignored.

Some other possible subspecific names of *Sorghum* subg. *Sorghum* that are earlier than those of Piper must be considered as well, although all apply to cultivated sorghum. One is "*Andropogon sorghum* subsp. *sativus*

Hack.", under which Hackel (1889) had included the annuals of this group, the perennials having been relegated to *A. sorghum* subsp. *halepensis* (L.) Hack. However, since the nomenclaturally typical element of the species was included within his annual subspecies by the citation of *Holcus sorghum* L. under its var. *vulgaris* (Pers.) Hack., "*A. sorghum* subsp. *sativus*" was not validly published (Art. 26.2). Hackel also automatically established the autonym, *A. sorghum* subsp. *sorghum*, which is homotypic with *S. bicolor* subsp. *bicolor*, through his creation of subsp. *halepensis* (Art. 26.3). The *Index to Grass Species* (Chase & Niles, 1962) lists an "*Andropogon sorghum* subsp. *I. effusus* Koern. Syst. Uebers. Cereal 20. 1873". Körnicke (1873) grouped a number of "Sorten" or "Varietäten" of domesticated *Andropogon sorghum* under "I. *effusus* Kcke." or "II. *Contractus* Kcke.", but did not indicate the rank nor provide a description or diagnosis, or a reference to such, for these entities. Both names are validly published with brief diagnoses in the first volume (pp. 306–307) of Körnicke & Werner (1885) without indication of their rank, but in the second volume (pp. 909, 912) they were labeled "Gruppe." Thus they cannot be considered subspecies. And finally, Ascherson & Graebner (1898) established "*Andropogon sorghum* subsp. '*A. eu-sorghum*' Asch. & Graebn.", *A. sorghum* subsp. '*A. saccharatus*' (L.) Asch. & Graebn. (based on *Holcus saccharatus* L.), and *A. sorghum* subsp. '*A. cernuus*' (Ard.) Asch. & Graebn. (based on *Holcus cernuus* Ard.). Although the first is not validly published (Art. 26.2) the last two are, although subject to correction under Art. 24.4.

## TAXONOMY AND NOMENCLATURE

De Wet's (1978) classification of *Sorghum bicolor* is reproduced below with the correct nomenclature, as well as the placement of all known subspecies names and any homotypic species names; varietal names are not included, except in the case of one upon which Piper based a subspecies name. The location of type specimens is, unless otherwise indicated, based on information provided in Piper (1915) and Snowden (1936).

***Sorghum bicolor*** (L.) Moench, *Methodus* 207. 1794 ≡ *Holcus sorghum* L., *Sp. Pl.* 2: 1047. 1753 ≡ *H. bicolor* L., *Mant. Pl.* 2: 301. 1771 ≡ *Andropogon sorghum* (L.) Brot., *Fl. Lusit.* 1: 88. 1804 – Lectotype (designated by Poilecot [for *H. bicolor*] in Boissiera 56: 509. 1999 and Davidse [for *H. sorghum*] in *Taxon* 49: 251. 2000): *Herb. Clifford*: 468, *Holcus* 1 (BM).

### ***S. bicolor* subsp. *bicolor***

= *A. sorghum* subsp. *cernuus* (Ard.) Asch. & Graebn., *Syn. Mitteleur. Fl.* 2(1): 51. 1898 "*A. cernuus*" ≡ *H.*

- cernuus* Ard. in Saggi Sci. Lett. Accad. Padova 1: 128, t. 3, figs. 1, 2. 1786 ≡ *S. cernuum* (Ard.) Host, Icon. Descr. Gram. Austriac. 4: 2. 1809 – Type: unknown, according to Snowden (1936) described from a cultivated sorghum in Italy.
- = *A. sorghum* subsp. *saccharatus* (L.) Asch. & Graebn., Syn. Mitteleur. Fl. 2(1): 48. 1898 “*A. saccharatus*”, nom. utique rej. ≡ *H. saccharatus* L., Sp. Pl. 2: 1047. 1753, nom. utique rej. ≡ *S. saccharatum* (L.) Moench, Methodus: 207. 1794, nom. utique rej. ≡ *S. vulgare* Pers. subsp. *saccharatum* (L.) Maire & Weiller in Maire, Fl. Afrique N. 1: 270. 1952, nom. utique rej. – Type: not designated (see Davidse & Turland 2001).
- = *S. vulgare* Pers. subsp. *durra* (Forssk.) Maire & Weiller in Maire, Fl. Afrique N. 1: 271. 1952 ≡ *Holcus durra* Forssk., Fl. Aegypt.-Arab.: 174. 1775 ≡ *S. durra* (Forssk.) Stapf in Prain, Fl. Trop. Afr. 9: 129. 1917 – Type (fide Hepper & Friis, 1994): *Forsskål III* (C). Cultivated grain sorghum. For more extensive synonymy see de Wet (1978).

- S. bicolor* subsp. *verticilliflorum*** (Steud.) de Wet ex Wiersema & J. Dahlb., **comb. nov.** Based on *Andropogon verticilliflorus* Steud., Syn. Pl. Glumac. 1: 393. 1854 ≡ *A. sorghum* subsp. *verticilliflorus* (Steud.) Piper in Proc. Biol. Soc. Wash. 28: 37. 1915 ≡ *S. verticilliflorum* (Steud.) Stapf in Prain, Fl. Trop. Afr. 9: 116. 1917 – Type: “Ins. Borbon.” [Réunion] (P?).
- = *A. sorghum* subsp. *vogelianus* Piper in Proc. Biol. Soc. Wash. 28: 34. 1915 ≡ *S. vogelianum* (Piper) Stapf in Prain, Fl. Trop. Afr. 9: 116. 1917 – Holotype: Nigeria, banks of Nun River, mouth of Niger River, 1840–1841, *Vogel II* (K).
- = *A. sorghum* subsp. *effusus* Piper in Proc. Biol. Soc. Wash. 28: 35. 1915, nom. illeg. (non “Gruppe” *effusus* Körn. 1885) ≡ *A. sorghum* var. *effusus* Hack. in Candolle & Candolle, Monogr. Phan. 6: 503. 1889, nom. illeg. (non “Gruppe” *effusus* Körn. 1885) ≡ *A. arundinaceus* Willd., Sp. Pl. 4: 906. 1806, nom. illeg. (non Berg 1767) ≡ *Rhaphis arundinacea* Desv., Opusc. Sci. Phys. Nat.: 69 (Mém. Soc. Agric. Angers 1: 173). 1831 “*arundinaceus*” ≡ *S. arundinaceum* (Desv.) Stapf in Prain, Fl. Trop. Afr. 9: 114. 1917 ≡ *S. bicolor* subsp. *arundinaceum* (Desv.) de Wet & Harlan ex Davidse in Monogr. Syst. Bot. Missouri Bot. Gard. 45: 1258. 1993 – Lectotype (selected by Piper, l.c. and confirmed here for *A. sorghum* var. *effusus* Hack.): Guinea, 1783–1786, *Isert s.n.* (B-W).
- = *A. sorghum* subsp. *abyssinicus* Piper in Proc. Biol. Soc. Wash. 28: 39. 1915, nom. illeg. (non var. *abyssinicus* Hack. 1889) ≡ *S. abyssinicum* Stapf in Prain, Fl. Trop. Afr. 9: 118. 1917, nom. illeg. (non (R.Br. ex Fresen.) Kuntze 1891) ≡ *S. macrochaeta* Snowden, Cult. *Sorghum*: 237. 1936 – Holotype: Sudan-Ethi-

- opian border, Gallabat-Matamma [Metema], 25 Jul 1865, *Schweinfurth 1521* (B; isotype: K).
- = *A. sorghum* subsp. *eichingeri* Piper in Proc. Biol. Soc. Wash. 28: 33. 1915 “*eichingeri*” – Holotype: Tanzania, “Buiho” [Buiko], Jun 1911, *Eichinger 3365* (B). Annual wild relatives of sorghum, native to Africa, Madagascar, and perhaps to the Mascarenes, but also introduced to India, Australia, and the Americas. For further synonymy see de Wet (1978) under “subsp. *arundinaceum*”.

- S. bicolor* subsp. *drummondii*** (Steud.) de Wet ex Davidse in Monogr. Syst. Bot. Missouri Bot. Gard. 45: 1258. 1993 ≡ *A. drummondii* Steud., Syn. Pl. Glumac. 1: 393. 1854 ≡ *S. drummondii* (Steud.) Millsp. & Chase in Publ. Field Columbian Mus., Bot. Ser. 2: 21. 1903 ≡ *A. sorghum* subsp. *drummondii* (Steud.) Piper in Proc. Biol. Soc. Wash. 28: 42. 1915 – Holotype: United States, Louisiana, New Orleans, 1832, *Drummond 588* (P?; isotypes: BM, CGE, K).
- = *A. sorghum* subsp. *sudanensis* Piper in Proc. Biol. Soc. Wash. 28: 33. 1915 ≡ *S. sudanense* (Piper) Stapf in Prain, Fl. Trop. Afr. 9: 113. 1917 – Holotype: “grown at Arlington Farm, Virginia, from seed secured from R. Hewison, Esq. [16 Mar 1909] Khartoum, Anglo-Egyptian Sudan”, Aug 1912, *Piper s.n.* (US No. 75608 [microfiche!]; isotype: US No. 82010 [microfiche!]). Original seed deposited at BARC (PI 25017).
- = *A. sorghum* subsp. *hewisonii* Piper in Proc. Biol. Soc. Wash. 28: 41. 1915 “*hewisonii*” ≡ *S. hewisonii* (Piper) Longley in J. Agric. Res. 44: 318. 1932. Type: “grown in the greenhouse from seed [“obtained from wild plants”] collected by R. Hewison, Esq., in Sennaar Province, Sudan”, received 29 May 1912 as USDA PI 33739 (not located) – Neotype (designated here): cultivated in Gainesville, Florida from PI 33739, 1915, *Piper s.n.* (US No. 31690391).
- = *A. sorghum* subsp. *niloticus* Stapf ex Piper in Proc. Biol. Soc. Wash. 28: 41. 1915 ≡ *S. niloticum* (Stapf ex Piper) Snowden in J. Linn. Soc., Bot. 55: 258. 1955. Holotype: Sudan, “Banks of White Nile a little south of Gaba Shambe”, 25 Jun 1862, *Petherick s.n.* (K). Annual weedy derivatives arising from hybridization of grain sorghum (subsp. *bicolor*) and its wild relatives (subsp. *verticilliflorum*). For further synonymy see de Wet (1978).

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