

TAXONOMY OF *DICHANTHIUM* SECTION *DICHANTHIUM* (GRAMINEAE) *

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The genus *Dichanthium* Willemet was treated as a subgenus of *Andropogon* L. by Hackel (1889, 1896). This classification was later adopted by Hooker and Stapf (1896) and Hitchcock (1935). However, Stapf (1917) and Camus (1921) suggested that the genera *Andropogon* and *Dichanthium* differ from each other so conspicuously that both deserve generic rank, and Blake (1944), Bor (1960) and Vickery (1961) further emphasized the necessity of recognizing both genera. Recently, de Wet and Harlan (1966) demonstrated that *Andropogon* is distinct from *Dichanthium*, but that the latter genus should be recognized to include *Bothriochloa* O. Kuntze and *Capillipedium* Stapf as sections. The present paper deals only with section *Dichanthium*.

The section *Dichanthium* is recognized to include only species with entire lemmas. Following Bor (1960), *D. polyptychum* (Steud.) A. Camus is transferred to *Andropogon* which it resembles in gross inflorescence structure, and in having bilobed lemmas. Similarly, *D. andringitrense* A. Camus probably also belong with *Andropogon*. The latter species is known only from the type, *de la Bathie* 13719 collected in central Madagascar (P), and differs from both *Andropogon* and *Dichanthium* in having the lower glume attenuate and the upper glume shortly but distinctly awned. Following Bor (1940, 1954), *D. serrafalcoides* (Cooke et Stapf) Blatt et McCann is retained in *Pseudodichanthium*, and *D. clarkei* (Hack.) Haines in *Indochloa*. Spikelet morphology definitely excludes *D. erectum* Ohwi, *Walsh* 45 collected in the lesser Sunda island of Timor (BM), from both *Dichanthium* and *Andropogon*. Comparative morphological studies

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with other *Andropogoneae* genera suggest that this species deserves generic rank.

DICHANTHIUM Section DICHANTHIUM

Dichanthium Willemet in Usteri, Neue Ann. der Bot. 18:11. 1796.

Lepeocercis Trin., Fund. Agrost. 203. 1820. *Diplastanthum* Desv., Opusc. 66. 1831.

Perennials, rarely annual; culmus slender to robust, simple or branched, erect, decumbent or trailing; nodes glabrous to villous, internodes glabrous, sometimes the culm just below the inflorescence pubescent. Leaf - sheaths terete or slightly compressed, glabrous to pilose; leaf-blades linear-lanceolate, glabrous to hairy, often cauline. Inflorescence usually subdigitate, rarely racemes solitary, more often few to many arranged on a short primary axis, pedunculate or subsessile, sometimes with the lower branches divided.

Spikelets paired, the one sessile and the other pedicellate, subequal to equal in size and shape, sometimes heteromorphous, usually different in sex, except the lower most 1 - 6 pairs which are with rare exceptions homogamous male or neuter. Spikelets arranged on a many jointed raceme, joints and pedicels filiform, solid. Fertile sessile and pedicellate spikelets deciduous, the former with adjacent joint and pedicel. Florets 2 in the fertile sessile spikelets, lower reduced to an empty lemma, upper bisexual; one in the barren sessile and pedicellate spikelets, male or neuter, suppressed or very rarely bisexual. Sessile spikelets dorsally compressed. Glumes subequal, chartaceous; lower obtuse, 2-keeled with inflexed margins, glabrous or variously ciliate, rarely pitted; upper boat-shaped, keeled, rarely longer than the lower, glabrous or ciliate along the keel and margins. Lemma of lower floret forming the hyaline base of an awn. Palea absent or minute. Lodicules 2, minute, glabrous. Stamens 3, rarely two. Stigmas laterally exerted at or above the middle of the spikelet. Grain dorsally compressed; embryo more than half as long as the grain. Pedicellate spikelets usually male or neuter, awnless, rarely awned and bisexual. Glumes as for the sessile spikelets, rarely with only the lower 1 - 6 sessile and pedicellate spikelets homomorphous, and the spikelets in the remaining pairs distinctly heteromorphous. Lemma often absent, hyaline when present, rarely awned.

The species and varieties of *Dichanthium* section *Dichanthium* may be distinguished, the one from the other, by the following key characters:

1. Lower 1-6 spikelet pairs homomorphous, the remaining sessile and pedicellate spikelets distinctly different; lower glume of the pedicellate spikelets armed with marginal bulbous-based bristles.
2. Lower glume of pedicellate spikelets pitted *D. panchaniense*.

2. Lower glume of pedicellate spikelets not pitted.
 3. Lower glume of sessile spikelets pitted **D. armatum.**
 3. Lower glume of sessile spikelets not pitted **D. maccannii.**
1. Spikelet pairs essentially all homomorphous; lower glumes never armed with marginal bulbous-based bristles, although often with bulbous-based cilia.
 4. Lower glume of the sessile spikelets ovate-lanceolate, mucronulate.
 - D. mucronulatum.**
 4. Lower glume of the sessile spikelets ovate to oblong-lanceolate, obtuse.
 5. Racemes sessile or subsessile; the lower glume of the sessile spikelets long-ciliate above the middle.
 6. Sessile spikelets 3-4.5 mm. long, pedicellate spikelets usually neuter.
 7. Racemes more than 15, pedicels usually essentially unilaterally ciliate **D. superciliatum.**
 7. Racemes 2-12, pedicels usually bilaterally ciliate.
 8. Racemes 4-7 cm. long; lower glume of the sessile spikelets with a distinct subapical fringe of cilia **D. sericeum.**
 8. Racemes 2-4 cm. long; lower glume of the sessile spikelets with the subapical fringe of cilia never prominent and less dense **D. humilium.**
 6. Sessile spikelets 5-6 mm. long; pedicellate spikelets often male; racemes 1-3 in number; lower glume of the sessile spikelets more or less uniformly hirsute all over back, with a distinct subapical fringe of cilia **D. setosum.**
 5. Racemes pedunculate, rarely subsessile, but then spikelets not long ciliate above the middle.
 9. Lower glume of sessile spikelets obovate to obovate-lanceolate, glabrous above the middle or shortly ciliate.
 10. Peduncles of the racemes pubescent **D. aristatum.**
 10. Peduncles of the racemes glabrous.
 11. Culms slender, erect, tufted **D. tenue.**
 11. Culms usually more robust, trailing or decumbent, rooting at the lower nodes.
 12. Racemes 2-10, rarely solitary per inflorescence; less than 75 mm. long **D. caricosum**
var.
caricosum.
 12. Racemes 1-3, often solitary, more than 75 mm. long.
D. caricosum
var.
theinlwini.
 9. Lower glume of sessile spikelets oblong to oblong-lanceolate, usually with long bulbous-based cilia along the margins above the middle.
 13. At least some pedicellate spikelets on each raceme bisexual and often shortly awned **D. annulatum**
var.
fecundum
 13. Pedicellate spikelets always male or neuter.

14. Spikelets pilose, with a distinct subapical fringe of long bulbous-based cilia **D. annulatum** var. **papillosum**.
14. Spikelets less pilose, with the bulbous-based cilia mainly along the margins of the lower glume **D. annulatum** var. **annulatum**.

DICANTHIUM ANNULATUM (Forssk.) Stapf

Dichanthium annulatum (Forssk.) Stapf in Prain, Fl. Trop. Afr. 9:178. 1917.

Andropogon annulatus Forssk., Fl. Aegypt. - Arab. 173. 1775.

A. annulatus var. *bladhii* (Retz) Hack. in DC., Monogr. Phan. 6:572. 1889.

A. annulatus var. *decalvatus* Hack. in DC., Monogr. Phan. 6:572. 1889.

A. annulatus var. *monostachya* F. Meull. ex Benth., Fl. Austr. 7:531. 1878.

A. annulatus var. *grandispiculatus* Domin, Biblioth. Bot. 85. 269. 1915.

A. bladhii Retz., Obs. Bot. 2:27. 1781.

A. obtusus Nees in Hook et Arn., Bot. Beech Voy. 243. 1838.

A. papillosus Hochst. in Rich., Tent. Fl. Abyss. 2:457. 1851.

A. scandens Roxb., Hort. Beng. 7. 1814. Nomen nudum.

Lepeocercis annulata (Forssk.) Nees, Fl. Afr. Austr. 98. 1841.

Dichanthium annulatum var. *decalvatum* (Hack.) Maire et Weiller, Fl. de L'Afr. du Nord 1:282. 1952.

D. fecundum S. T. Blake, Queensl. Univ. Dept. Biol. papers 2:51. 1944.

D. papillosum (Hockst.) Stapf in Prain, Fl. Trop. Afr. 9:179. 1917.

Perennial; culms up to 100 cm. tall, suberect or geniculate-ascending, simple or branched. Leaf-sheaths glabrous, bearded at the nodes or sparsely hairy all over; ligule scariosus; leaf-blades linear-lanceolate, up to 30 cm. long, usually shorter, glabrous or sparsely hairy, leaves often mainly cauline. Inflorescence subdigitate; racemes 2 - many arranged on a short primary axis, lower inflorescence branches sometimes divided; rachis and pedicels solid, usually ciliate.

Sessile spikelets subimbricate, oblong, 2-6 mm. long, the lower 1-6 usually male or neuter, the remaining bisexual. Glumes subequal; lower glume slightly concave, usually pubescent below the middle, often with long bulbous-based cilia above the middle along the margins and across the apex, vary rarely glabrous or almost so; upper glume slightly shorter than the lower, glabrous except for the keel and apex which are often shortly ciliate. Lemma of lower floret hyaline, empty; of upper floret forming the hyaline base of an 8-25 mm.

long awn; anthers 3. Pedicellate spikelets equal or subequal in size and shape to the sessile ones, usually male or neuter and awnless, more rarely bisexual and awned.

The species *D. annulatum*, *D. fecundum* and *D. papillosum* are usually recognized as distinct taxonomic units (Blake, 1944; Bor, 1960; Vickery, 1961). Cytogenetical data presented by Borgaonkar, Harlan and de Wet (1962), Borgaonkar and Singh (1962), Mehra (1962, 1964), and Singh and Mehra (1965) demonstrated that *D. papillosum* and *D. fecundum* are apomictic derivatives of *D. annulatum*. As these three taxonomic units are quite distinct morphologically, *D. fecundum* and *D. papillosum* are recognized as varieties of *D. annulatum*.

DICHANTHIUM ANNULATUM (Forssk.) Stapf. var. ANNULATUM

Clums prostrate, geniculately ascending or more rarely suberect. Inflorescence with 2-many, 30-70 mm. long, simple or divided racemes arranged along a short primary axis. The lower glume of the sessile spikelets is usually below the middle, with longer bulbous-based cilia along the margins and near the apex.

Celazier, Mehra and Wulf (1958), and Mehra (1962) demonstrated the presence of two ecotypes. The tropical ecotype, extending from Afghanistan to Australia, is characterized by diploid and tetraploid races. The diploids are slender creepers, while the tetraploids are more robust and prostrate to almost erect in growth habit. The Mediterranean ecotype extends from West Pakistan to the coastal areas of northern Africa. These plants are strictly tetraploid, decumbent or suberect in growth habit, and differ from the tropical ecotype in having more slender racemes arranged on a slightly elongated primary axis.

Distribution: Widely distributed from western North Africa to Indonesia. Introduced to central Africa and Australia.

Cytology: Diploid ($2n = 20$) and tetraploid ($2n = 40$) races are known. The diploids are characterized strictly by bivalent formation during microsporogenesis, and they reproduce sexually. Tetraploids are facultative gametophytic apomicts, and the chromosomes usually associate into bivalents during microsporogenesis with univalents and multivalents present in some cells.

Type locality: Egypt, "Passim ad ripas Nili". Type not seen.

REPRESENTATIVE SPECIMENS: MOROCCO: without locality, *Jahandiez* 254 (BM); *Okla* 94; Ait Hamadi, *Okla* 7419. ALGIERS: Biskra, *Balanza* 1853 (BM). LIBYA: M'laghi, *Guichard* 122 (BM). SENEGAL: Dakar, *Okla* 5430. TUNESIA:

Zerkine, *Okla* 4390; Gabes, *Okla* 4391. SUDAN: Kosti, *Davies* 104 (K); Kordafan, *Harrison* 915 (K). SOMALILAND: Adad Kulali, *McKinnon* 587 (K); Engavo, *McKinnon* 5123 (K). TANZANIA: Central Provinces, *van Rensburg* 480 (K); without locality, *Okla* 2653. KENYA: Athi River, *Bogdan* 2201 (K). EGYPT: Cairo, *Keller* 37 (K); Giza, *Okla* 3787. SAUDI ARABIA: without locality, *Okla* 4830. ISRAEL: Gallilea, *Okla* 3565. IRAQ: Baghdad, *Okla* 5113. AFGHANISTAN: Kandahar, *Okla* 6225; Kabul, *Okla* 6573. PAKISTAN AND INDIA: Sargodha, *Okla* 4634; Thal, *Okla* 8859; Dalhousie, *Okla* 8878; Lashar, *Okla* 8853; Jalahbad, *Okla* 8854; Tarnab, *Okla* 8855; Peshawar, *Okla* 8856, 8856a; Rawalpindi, *Okla* 8862; Simla, *Okla* 8872b; Murree, *Okla* 8868; Mansehra, *Okla* 8870; Parachinor, *Okla* 8871; Udampur, *Okla* 8876; Abbotabad, *Okla* 8907b; New Delhi, *Okla* 5405; Dehra Dun, *Okla* 8453; Allahbad, *Okla* 3227; Calcuta, *Okla* 3242, 6180; Nadia, *Okla* 4565; Hyderabad, *Okla* 4019; Ajmer, *Okla* 4045; Himayet Sagar, *Okla* 4593; Lucknow, *Okla* 4600; Poona, *Okla* 5238; Coimbatore, *Okla* 5295; Dharwar, *Okla* 5292; Karnal, *Okla* 5398; Belatal, *Okla* 5396a; Hempur, *Okla* 8542; Bombay, *Okla* 5797; Amritsar, *Okla* 6866; Palampur, *Okla* 7018b; Barnares, *Okla* 7133; Ajmer, *Okla* 8880; Johdpur, *Okla* 8881; Kotah, *Okla* 8883b; Aligarh, *Okla* 8884; Kalka, *Okla* 8974b; Mt. Abu, *Okla* 9030. BURMA: Mandalay, *Okla* 6192. CHINA: Southern, *Okla* 6154b. MALAYSIA: Singapore, *Okla* 10649. FIJI: Nandi, *Okla* 5593; Suva, *Okla* 5602. PHILIPPINES: Luzon, *Okla* 6897. INDONESIA: Java, *Okla* 6884. NEW GUINEA: Port Morseby, *Okla* 7571. AUSTRALIA: Northern territory; Katherine, *Hartley* 11740 (K); Queensland; Townsville, *Okla* 10790, Ingham, *Okla* 10811; Eimoe, *Okla* 10891; Nebo, *Okla* 10892; Mackay, *Okla* 10893.

DICHANTHIUM ANNULATUM var. **FECUNDUM** (S. T. Blake) de Wet et Harlan comb. nov.

Dichanthium fecundum S. T. Blake, Queensl. Univ. Dept. Biol. Papers 2:51. 1944.

Andropogon annulatus var. *grandispiculatus* Domin, Biblioth. Bot. 85:269. 1915.

A. annulatus var. *monostachya* F. Muell. ex Benth., Fl. Austr. 7:531. 1878.

Blake (1944) pointed out that the two varietal names proposed *Andropogon annulatus* var. *grandispiculatus* and var. *monostachya*, do not describe this variety completely. For this reason, Blake based *D. fecundum* on a new type. The racemes are only rarely solitary, more often 2-6 in number and although the spikelets are large, some specimens of typical *D. annulatum* are characterized by equally large sessile spikelets.

This variety is characterized by having, except for the lower 1-3 spikelet pairs which are male or neuter, usually bisexual pedicellate spikelets. Bisexuality of the pedicellate spikelets is often accompanied by a lemma which ends in a well developed awn. Borgaonkar and de Wet (1960) demonstrated that this variety crossed readily with typical *D. annulatum* and that the distinguishing features are controlled by a group of closely linked dominant genes.

Distribution: Australia; widely distributed in the more tropical regions of Western Australia, Northern Territory and Queensland, also in New Guinea.

Cytology: Essentially obligate gametophytic apomists with $2n = 40$ and 60 chromosomes. Although multivalents and univalents characterize many developing microspore mother cells, some cytologically balanced gametes are almost always produced.

Type locality: Australia, Queensland, Ayr in damp open places; *Blake 8337* (BRI).

REPRESENTATIVE SPECIMENS: AUSTRALIA: Western Australia; *Kalamburu, Lazarides 4848* (K). Northern Territory; Wollongorang, *Perry 1158* (K). Queensland; Toorak, *Lazarides 4448* (K); Burke district, *Blake 9234* (K); Leichardt district, *Blake 8126* (K); Port Curtis, *Blake 7813* (K); Cloncurry, *Blake 6357* (K); Townsville, *Okla 6525, 10780, 10830, 10831*; Giru, *Okla 10781, 10792*; Ayr, *Okla 10791, 10804*; Rockhampton, *Okla 10856*; Oxford Downs, *Okla 10918*. NEW GUINEA: Papua, *Dept. of Forests 4734* (L); Port Morseby, *Brass 8787* (L); Kanosia, *Carr 1111* (L).

DICHANTHIUM ANNULATUM var. **PAPILLOSUM** (Hochst.) Pilger,
Willdenowia 1954.

Andropogon papillosus Hochst. in Rich., Tent. Fl. Abyss. 2:457. 1851.

Andropogon annulatus var. *papillosus* (Hochst.) Rendle, Cat. Afr. Pl. Welw. 2:150. 1899. Not of Hook. f. 1896.

Dichanthium papillosum (Hochst.) Stapf in Parin, Fl. Trop. Afr. 9:179. 1917.

This variety is characterized by pilose spikelets with long bulbous-based cilia forming a more or less distinct subapical fringe on the lower glume of sessile spikelets. Except for glume pubescence, this variety is often difficult to separate from suberect, robust specimens of *D. annulatum* var. *annulatum*. Borgaonkar and Singh (1962) demonstrated that *D. annulatum* var. *papillosum* is hexaploid ($2n = 60$) while typical representatives of the species are tetraploid. Cytogenetical data (Borgaonkar and Singh, 1962) indicated that artificially produced hybrids between tetraploid representatives of *D. annulatum* var. *annulatum* are often hexaploid, and some of these can not be distinguished morphologically from the natural hexaploid *D. annulatum* var. *papillosum*.

Distribution: Tropical and subtropical Africa.

Cytology: Strictly hexaploid ($2n = 60$) and essentially an obligate apomict. Chromosome association during microsporogenesis is very irregular, with univalents and multivalents often present. Some functional and cytologically balanced pollen, however, is always produced.

Type locality: Africa, Abyssinia; Schimper Abyss. Sect. 11, N° 526.

REPRESENTATIVE SPECIMENS: SUDAN: Equatoria, *Davies E6* (K). UGANDA: Rom, *Liebenberg 1827* (K); Kamalinga, *Thomas 2248* (K); Karamoja, *Mitchellmore 1272* (K). KENYA: Makipenzi, *Bally 9735* (K); Yatta Plains, *Edwards 70* (K). TANZANIA: Mbulu, *Lamprey 299* (K); Sambala, *Burt 2604* (K); Mbulumbulu, *Green-Way 6771* (K); Shinyanga, *Burt 5692* (K). MALAWI: Palombe Plains, *Jackson 804* (K). ANGOLA: Loanda, *Welwitsch 7323* (K). RHODESIA: Kafue, *Hinds 228* (K); Nuanetsi, *Robinson 447* (K); Wankie, *Davies 1041* (K); Matopo, *Rattray 1601* (K); Lupani, *Okla 9502*; Kenmaar, *Okla 9503*; Bulawayo, *Okla 3716*. BOTSWANA: Francistown, *Pole Evans 3228-26* (K). SOUTH AFRICA: Gordonia, *Leistner 1015* (K); Marble Hall, *Okla 9690*; Nylstroom, *Okla 9691*; Warmbaths, *Okla 9692*; Zeerust, *Okla 9693*; flithout locality in Northern Transvaal, *Okla 4081, 4083, 4105, 4106, 5512*.

DICHANTHIUM ARISTATUM (Poir.) C. E. Hubbard

Dichanthium aristatum (Poir.) C. E. Hubbard, Kew Bul. 1939:654. 1939.

Andropogon aristatus Poir, in Lamk., Encycl. Meth. Bot. Suppl. 1:585. 1810.

A. mollicomus Kunth, Rev. Gram. 1:365. 1830.

A. caricosus spp. *mollicomus* Hack. var. *mollicomus* (Kunth) Hack. in DC., Monogr. Phan. 569. 1889.

Diplasanthum lanosum Desv., Oppusc. 67. 1831.

Lepeocercis mollicoma (Kunth) Nees; Edinb. New Phil. Jour. 18:185. 1835.

Dichanthium nodosum Willem. in Usteri, Ann. Bot. 18:11. 1796. Willemet cited *A. annulatus* Forssk. as a synonym, but a Mauritius plant with pilose peduncles was described. The epithet "nodosum" became illegitimate, because *A. annulatus* later became the type for *Dichanthium annulatum*.

Andropogon nodosus (Willem.) Nash, No. Amer. F. 17:122.

Dichanthium caricosum var. *mollicomus* (Hack.) Haines, Bot. Bihar and Orissa 5:1039. 1924.

Perennial; culms up to 100 cm. tall, simple or branched, suberect or more rarely decumbent, Leaf-sheaths glabrous or bearded at the nodes and ciliate along the margins; ligule scarious; leaf-blades linear - lanceolate up to 25 cm. long, glabrous or sparsely hairy. Inflorescence rarely with a single raceme, more often with 2-many racemes subdigitately arranged on a short primary axis; rarely with the lower inflorescence branch divided, peduncles pilose, and the culm below the inflorescence usually hairy; rachis and pedicels, solid, usually ciliate.

Sessile spikelets closely imbricate, obovate, 2 - 5 mm. long, lower 1-6 male or neuter, the upper ones bisexual. Glumes subequal in size, lower glume often minutely winged, pilose below the middle, glabrous or shortly ciliate above the middle along margins and near the apex, rarely completely glabrous; upper glume as long as the lower, glabrous or ciliate along the margins and keel. Lemma of lower floret hyaline and empty; of upper floret forming the hyaline base of a

well developed awn; anthers 3. Pedicellate spikelets subequal in size and shape to the sessile ones, male or neuter, awnless.

This variable species recognized to include all plants of *Dichanthium* with pilose peducles. Typically, *D. aristatum* is characterized by robust, suberect plants having the peduncles to the racemes densely villous, and the culm below the inflorescence strongly pilose. However, some plants are decumbent with sparsely pubescent peduncles, and the culm below the inflorescence is often almost glabrous. These sparsely pilose plants resemble artificially produced hybrids between *D. aristatum* and the related *D. caricosum* (Celarier, de Wet and Richardson, 1961; Celarier, de Wet and Bakshi, 1962). Pandeya (1953) suggested that *D. aristatum* represents nothing more than an ecological race of *D. caricosum* but de Wet and Singh (1964) indicated that these two species are genetically isolated from each other at the diploid level, and at the polyploid level they cross only with difficulty. For these reasons, *D. aristatum* and *D. caricosum* are treated as separate species. Varieties are not recognized within *D. aristatum* because of the hybrid nature of the aberrant specimens. These are included in *D. aristatum* for convenience, the type character (hairyness of the peduncle) being genetically dominant over glabrous peduncles.

Distribution: Tropical India, extending eastward to Indonesia. This species was introduced to most tropical regions of the World and became naturalized in Australia, Africa and the Americas.

Cytology: Tetraploid ($2n = 40$), diploid ($2n = 20$) and hexaploid ($2n = 60$) races were collected. The diploids reproduce sexually, while the polyploids are facultative apomies. Microporogenesis of the polyploids is characterized mostly by bivalent formation, but multivalents and univalents were present in some cells.

Type locality: Mauritius; *Commerson*, Herb. Desfontaines (FI).

REPRESENTATIVE SPECIMENS: SOUTH AFRICA: Pretoria, Okla 9688, 9689. RHODESIA: Sinoia, Okla 9506. INDIA: New Delhi, Okla 4086, 9035, 9424, 9425; Sangar, Okla 5287; Indore, Okla 5326; Poona Okla 8371, 9059; Bombay, 5795; Bihar, Okla 6177, 6178; Madras, Okla; 6179; Sangli, Okla 7199; Mt. Abu, Okla 9031b, 9056; Nasik, Okla 9038; Mysore, Meebold, 10492 (K), 10777 (K); Coimbatore, Fischer 1437 (K). PHILIPPINES: Laguina, Okla 6406. INDONESIA: Java, Paseroean, Backer 37454 (L); Madioen, Wisse 690 (L); Paiton, Backer 12986 (L); Timor, de Froideville 1030 (L); Sumba, de Froideville 1885 (L); de Froideville 1890 (L); Selebes, Thellberg 3038 (L). AUSTRALIA: Queensland; Fernvale, Okla 10758; Townsville, Okla 10799; Ingham, Okla 10803.

DICHTANTHUM ARMATUM (Hook. f.) Blatt. et McCann

Dichanthium armatum (Hook. f.) Blatt. et McCann, Jour. Bombay Nat. Hist. Soc. 32:425 1928.

Andropogon armatus Hook. f., Fl. Brit. India 7:197. 1896.

Annual; culms erect and tufted, up to 45 cm. tall, simple or branched. Leaf-sheaths glabrous except at the margins and at the bearded node; ligule minute; leaf-blades linear-lanceolate, 10-15 cm. long, conspicuously hairy on both surfaces. Inflorescence subdigitate; racemes 2 - 5, flexuous, simple; rachis and pedicels solid and ciliate.

Sessile spikelets imbricate, 3 mm. long, lower 1-3 male, upper ones bisexual. Glumes subequal to unequal; lower glume of bisexual sessile spikelets hairy below the middle and glabrous above, with a distinct circular dorsal pit; lower glume of male sessile spikelets resembling that of the pedicellate spikelets; upper glume of both bisexual and male sessile spikelets silky villous on the back. Lemma of the lower floret hyaline, empty; of the upper floret forming the hyaline base of a 20 - 25 mm. long awn; anthers 3. Pedicellate spikelets male of neuter, resembling the lower sessile spikelets, awnless. Lower sessile spikelets, awnless. Lower glume not pitted, armed with marginal bulbous-based bristles, smooth between the bristles; upper glume ciliate. Lemma of the lower floret absent; of upper floret narrow, and usually including three anthers.

Distribution: Apparently endemic in western India

Type locality: India, Concan: Stocks s.n. (K.).

Cytology: Sexually reproducing diploid ($2n = 20$).

REPRESENTATIVE SPECIMENS: INDIA: Bombay, *McCann* 9430 (K).

DICHANTHIUM CARICOSUM (L.) A. Camus

Dichanthium caricosum (L.) A. Camus, Bull. Mus. Hist. Nat. Paris 27:549. 1921.

Andropogon caricosus L., Sp. Pl. ed. 2:1480. 1763.

A. serratum Retz., Obs. Bot. 5:21. 1789.

A. filiformis Pers., Synop. Pl. 1:103. 1805.

A. caricosus subsp. *genuinus* Hack. in DC., Monogr. Phan. 6:568. 1889.

Apoecpis pallida Hook. f., Fl. Brit. India 7:145. 1896.

Heteropogon concinnus Thw., Enum. Pl. Zeyl. 368. 1864.

Dichanthium caricosum (L.) Stapf in Ridley, Fl. Malay Penins. 5:210. 1925.

D. pallidum (Hook. f.) Stapf ex Fischer in Gamble, Fl. Pres. Madras 10:1740, 1741. 1934.

D. theinlwinii Bor, Kew Bull. 1949:223. 1949.

Perennial; culms usually robust, ascending from a creeping base, often forming tufts at the rooted nodes. Leaf-sheaths hairy along the margins and at the node, more rarely completely glabrous; ligule a ciliate membrane; leaf-blades linear-lanceolate, up to 20 cm. long, glabrous or sparingly hairy. Inflorescence subdigitate; race-

mes solitary, 2-nate or more often 3-10 arranged along a short primary axis.

Sessile spikelets 3-4 mm. long, obovate, lower 1-3 male or neuter, the upper ones bisexual. Glumes subequal; lower glume ciliate below the middle, glabrous above or with scattered longer hairs near the apex and along the margins, rarely with scattered long hairs all over; upper glume often slightly longer than the lower ones, ciliolate along the keel. Lemma of lower floret hyaline and empty; of upper bisexual floret forming the hyaline base of a well developed awn; anthers 3. Pedicellate spikelets subequal in size and shape to the sessile ones, awnless, male or neuter.

The endemic *D. pallidum*, known from the type only (*Foulkes s. n.*, Nilgiris, India), is characterized by solitary racemes which are composed of tightly overlapping spikelets with distinctly grooved lower glumes. More slender representatives of *D. caricosum*, in particular *Wallace 18*, *Clarke 34467*, *Bourne 2453* (filed with Kew) and *Okla 10026* from the type locality in the Nilgiris have tightly overlapping spikelets and at least some sessile spikelets are grooved. As these two species grade into each other, *D. pallidum* is included in *D. caricosum*. Two other Kew specimens, *Fisher 1437* and *Madras Herb. N° 12469* both from India, which are included in *D. aristatum* on the basis of peduncle pubescence have slender culms with the spikelets on the solitary racemes tightly overlapping as is characteristic of *D. pallidum*.

This morphologically variable species is subdivided into two varieties.

DICHANTHIUM CARICOSUM (L.) A. Camus var. CARICOSUM

Culms usually robust and prostrate, more rarely decumbent, usually purple tinted at the nodes. Inflorescence with 2-10 racemes arranged on a short primary axis, or rarely with a solitary raceme. Racemes less than 75 mm. long usually 30-65 mm. in length and 1-2, 2-5 or 6-10 per inflorescence.

Distribution: Tropical India, extending to southern China and Indonesia.

Cytology: Diploids ($2n = 20$) reproduce sexually while tetraploids ($2n = 40$) are facultative apomicts. The chromosomes of the tetraploids usually associate into bivalents during microsporogenesis, but multivalents are sometimes formed, or some chromosomes may fail to pair.

Type locality: India; *Linnean Herb.* Type not seen.

REPRESENTATIVE SPECIMENS: INDIA: Madras, *Beddome* 73 (K); Bengal, *Clarke* 34467 (K); Poona, *Okla* 5280, 5440, 8374, 8444, 8449, 8452b, 9023, 9053, 9054; Rohtak, *Okla* 5399; Lonavala, *Okla* 8280; Jamgaon, *Okla* 8373; Bombay, *Okla* 8374b; Mt. Abu, *Okla* 9032; Nasik, *Okla* 9062, 9063; Nilgiris, *Okla* 10026. BURMA: Chittor, *Kurz* 2733 (K). THAILAND: Bangkok, *Kerr* 9 (K), *Kerr* 361 (K), *err* 3894 (K); Takali, *Putt* 2146 (K); Keng Koi, *Kerr* 7592 (K). LAOS: Tonkin, *Balanza* 1755 (K). CHINA: Yun-nan, *Delavay* 1807 (L). MALAYSIA: Kuala Lumpur, *Okla* 2583, 4029; Singapore, *Okla* 10645, 10650, 10847, 10873. INDONESIA: Java, Pasoeroean, *Backer* 24299 (L), 36574 (L); Banjoewangi, *Beguin* 188 (L); Baluran, *Kappard* 245 (L); Kendal, *Backer* 16353 (L).

DICHANTHIUM CARICOSUM var. **THEINLWINII** (Bor) de Wet et Harlan
Comb. nov.

Dichanthium theinlwinii Bor, Kew Bull. 1949:223. 1949.

Culms decumbent, robust. Inflorescence with a single, or more rarely 1-3-nate racemes which are 75-85 mm. long. Lower glume of sessile spikelets strongly pilose below the middle, with scattered longer hairs above the middle and near the apex.

Bor (1960) included plants with 75-80 mm. long solitary racemes in *D. theinlwinii* and indicated that this species is known from the type (*Thein Lwin*, Burna) only. Some plants with 65-85 mm. long racemes, collected in Thailand (*Kerr* 11096, 10092, 10052, *Okla* 10616) and Java (*Backer* 24299) differ from *D. theinlwinii* only in having 1-3 racemes per inflorescence and somewhat less pilose glumes. Other one-racemed specimens from these regions have shorter racemes and are included in typical *D. caricosum*. Because of the close resemblance in gross morphological characteristics between *D. caricosum* and *D. theinlwinii* these two species are combined into a single taxonomic unit. The very large solitary, or more rarely 1-3-nate racemes are so obviously different from the smaller racemes of *D. caricosum*, that *D. theinlwinii* at least deserves varietal rank.

Distribution: Burma to Java.

Cytology: Tetraploid ($2n = 40$), behaving cytologically like a segmental allopolyploid, and the plant studied is a facultative apomict.

Type locality: Burma, Tanlugon; *Thein Lwin* (K).

REPRESENTATIVE SPECIMENS: THAILAND: Thon Buri, *Okla* 10616; Chiang Mai, *Khantachai* 720 (K); Bangkok, *Kerr* 11096 (K), *Kerr* 10092 (K), *Kerr* 10052 (K). INDONESIA: Java, Pasoeroean, *Backer* 24299 (L).

DICHANTHIUM HUMILIUS (Benth.) J. M. Black

Dichanthium humilium (Benth.) J. M. Black, Trans. and Proc. Roy. Soc. So. Austral. 60:165. 1936.

Andropogon annulatus var. (?) *humilis* Benth., Fl. Austr. 7:531. 1878.

A. sericeus var. *geniculatus* F. M. Bail., Queensl. Agric. Jour. 25: 123. 1911.

Annual or perennial; culms erect, 10 - 40 cm. tall, rather slender, simple or branched. Leaf-sheaths usually glabrous except at the bearded nodes; ligule membraneous; leaf-blades often blue tinted, usually glabrous or almost so. Inflorescence digitate; racemes sessile or subsessile, usually 1-3, more rarely 1-6, white villous, 15-40 mm. long undivided.

Sessile spikelets 3-4 mm. long, elliptical-oblong, truncate at the apex, lower 1-3 male or neuter, the upper ones bisexual. Glumes subequal; lower glume shortly pilose below the middle, sparsely long ciliate on the keels in the upper part forming a transverse fringe near the apex of approximately 6 mm. long bulbous-based hairs; upper glume as long as, or slightly longer than the lower, glabrous. Lemma of lower floret hyaline and empty; of upper bisexual floret forming the base of a 20-25 mm. long awn; anthers 3. Pedicellate spikelets neuter, reduced to the glumes, long ciliate, awnless.

This species is closely related to *D. sericeum* which it resembles in most characteristics. Vickery (1961) indicated that *D. humiliss* can be distinguished from *D. sericeum* by its slender culms, shorter racemes and less hairy inflorescences. Genetically these two diploid species seem to be isolated, and for this reason they are treated as distinct species.

Distribution: Australia, widely distributed.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: Australia, Charlotte waters; *Giles* (K).

REPRESENTATIVE SPECIMENS: AUSTRALIA: Queensland; Emu Park, *Okla* 10858; Tummaville, *White* 12590 (K); Curravilla, *Everest* 3910 (K); Port Curtis, *Blake* 12717 (K); Without locality, *Okla* 7256, 7534, 7567, 9971a. Western Australia, Eremean, *Speck* 618 (K); Wandagee, *Gardner* 3257 (K); Waramblea, *Burbridge* 417 aKq. South Australia; Mt. Lyndhurst, *Koch* 21 (K). New South Wales: Armidale, *Okla* 3723.

DICHANTHIUM MACCANNII Blatter

Dichanthium maccannii Blatter, Jour. Bombay Nat. Hist. Soc. 32:357. 1927.

The type of this species is neither in Kew nor in St. Xaviers College. This species was recently collected (*Okla* 9049) from the type locality, east of the third tableland of Panchgani. The following description is based on this collection.

Annual; culms tufted, erect, up to 45 cm. tall, simple or branched. Leaf-sheaths glabrous except on the margins and at the bearded

nodes; ligule a ciliate membrane; leaf-blades up to 12 cm. long, linear-lanceolate, covered with long bulbous based hairs. Racemes solitary or 2-4, subdigitately arranged along a short primary axis; rachis and pedicels of the lower 3 or 4 spikelets pairs glabrous, of the rest ciliate mainly along one side.

Sesile spikelet 3,5-4,5 mm. long, elliptic-oblong, lower 3-4 male or neuter and awnless, the upper ones bisexual. Glumes subequal; lower glume of male and neuter sessile spikelets with a few long bulbous-based cilia above the bearded callus, and long bulbous-based bristles along the margins above the middle, forming a subapical fringe, distinctly winged; upper glume slightly longer than the lower, hairy towards the tip along the margins and on the keel; lower glume of bisexual sessile spikelets glabrous below the middle, with a few long bulbous-based hairs near the apex, Lemma of the lower floret hyaline, empty; of upper bisexual floret forming the hyaline base of a 25-30 mm. long awn; anthers 2. Pedicellate spikelets distinctly longer than the sessile ones, broadly lanceolate, male or neuter, awnless; glumes as for the male or neuter sessile spikelets.

This species resembles *D. panchganiense* in spikelet morphology, but the lower glume is never pitted, and the plants are more robust. It was demonstrated by de Wet and Singh (1964) that these two species are genetically isolated from each other.

Distribution: India; endemic to a small region east of the third table land of Panchgani.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: India, East of the third table land of Satara District, Panchgani; *McCann Oct. 1925*. This specimen is missing from St. Xaviers College (BLAT).

REPRESENTATIVE SPECIMENS: INDIA: Panchgani, *Okla 9049* (From type locality).

DICHANTHIUM MUCRONULATUM Jansen

Dichanthium mucronulatum Jansen, Acta Bot. Neerl. 1:373, 474. 1952.

Perennial; culms robust, erect, up to 80 cm. tall, simple or branched. Leaf-sheaths glabrous except at the often bearded nodes; ligule membranaceous; leaf-blades up to 20 cm. long glabrous or with long hairs near the base. Racemes solitary at the end of the culms and their branches; rachis and pedicels solid, ciliate.

Sessile spikelets 5-6 mm. long, linear-oblong, bisexual except for the lower 1-3 on each raceme which are male or neuter. Glumes

subequal; lower glume glabrous except for the minutely ciliate margins, distinctly micronulate; upper glume acute, often minutely bidentate, glabrous. Lemma of lower floret hyaline, empty; of upper bisexual floret forming the base of a 25-30 mm. long awn anthers 3. Pedicellate spikelets male or neuter, awnless, glabrous, about as large as the sessile ones.

Distribution: Malayan peninsula.

Cytology: Not known.

Type locality: Malaysia, Kedah; *Ridley 8129* (L).

REPRESENTATIVE SPECIMENS: MALAYSIA: Kedah, *Corner and Nauen* (K); Selagor, *McNur* (BM); Langkawi, *Corner* (K).

DICHANTHIUM PANCHGANIENSE Blatt. et McCann

Dichanthium panchganiense Blatt. et McCann, Jour. Bombay Nat. Hist. Soc. 32:357. 1927.

Annual; culm erect, up to 40 cm. tall, slender: Leaf-sheaths covered with bulbous-based hairs along the margins in upper part; leaf-blade up to 10 cm. long, ciliate on the margins, and with longer bulbous-based hairs on both surfaces. Inflorescence digitate with 1-4 racemes on slender peduncles.

Sessile spikelets 3-4 mm. long, broadly oblong, lower 3-4 male or neuter and awnless, the upper ones bisexual. Glumes subequal; lower glume of male or neuter sessile spikelets hirsute throughout, with long bulbous-based bristles along the margins and near the apex, almost always pitted; lower glume of bisexual spikelets with a distinct dorsal pit about 1/3 from the apex, hirsute below, and glabrous above the pit; upper glume longer than the lower, glabrous except for the ciliate keel. Lemma of lower floret hyaline and empty; of upper bisexual floret forming the base of a well developed awn. Pedicellate spikelets distinctly larger than the sessile ones, 4-5 mm. long, awnless, male or neuter. Glumes subequal, with the upper slightly longer; lower glume always pitted, armed with marginal bulbous-based bristles, hairy between the bristles.

Distribution: India; endemic to Panchgani.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: India, Satara, Panchgani; *McCann Nov. 1925* (BLAT; K).

REPRESENTATIVE SPECIMENS: INDIA: Panchgani, *Okla 8278, 9039, 9041*.

DICHANTHIUM SERICEUM (R. Br.) A. Camus

- Dichanthium sericeum* (R. Br.) A. Camus, Bull. Mus. Hist. Nat. Paris 27:549. 1921.
Andropogon sericeus R. Br., Prod. Fl. Nov. Holl. 1:201. 1810.
A. affine R. Br., Prod. Fl. Nov. Holl. 1:201. 1810.
A. chrysantherus F. Muell., Linnaea 25:443. 1852.
A. jubatus Balansa, Bull. Soc. Bot. Fr. 19:322. 1872.
A. acutiusculus Hack. in DC., Monogr. Phan. 6:575. 1889.
A. sericeus var. *mollis* F. M. Bailey, Queensl. Agr. Journ. 30:316. 1913.
Dichanthium acutiusculum (Hack.) A. Camus, Bull. Mus. Hist. Nat. 27:549. 1921.

Annual or perennial; erect or slightly decumbent, culms up to 100 cm. tall, often slender. Leaf-sheaths glabrous to pilose; leaf-blade linear-lanceolate, up to 15 cm. long, glabrous to pilose all over. Racemes digitate, with 1-15 sessile to subsessile white villous racemes.

Sessile spikelets 3-4 mm. long, elliptical-oblong, truncate at the apex, lower 1-6 male or neuter and awnless, upper ones bisexual. Glumes subequal; lower glume obtuse or obtusely bilobed, pilose or rarely glabrous on the back below the middle, always with longer bulbous-based cilia along the margins forming a transverse sub-apical fringe; upper glume usually slightly longer than the lower, glabrous. Lemma of lower floret hyaline, empty; of upper bisexual floret forming the base of a well developed awn; anthers usually 2. Pedicellate spikelets neuter, about 3 mm. long, obovate-oblong, reduced to the glumes, long ciliate.

Pubescence of the leaf-sheaths and leaf-blades is a continuously variable character. Plants may be completely glabrous to hirsute all over. The pilose form of this species was recognized as a variety, *D. sericeum* var. *mollis*, by de Wet et Harlan (1962). However, although distinct, it is often difficult to decide whether a plant is sufficiently pilose to be included in this variety.

Distribution: Widely distributed in Australia, but mainly in the north, also present in New Guinea.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: Australia, Port Jackson; *R. Brown 6178* (BM).

REPRESENTATIVE SPECIMENS: AUSTRALIA: *South Australia*; Cordillo Downs, Cleland H-207 (K). Northern Territory; Birrimbah, Perry 2067 (K); Dorisvale, Lazarides 2786 (K). New South Wales; Lightning Ridge, Constable 18666 (K); Nevertire, Helms 31603 (K); Broken Hill, Constable 7917 (K); Mt. Stuart, Constable 10375 (K); Hunter Valley Okla 9970, 9973, 9975. Queensland; Brisbane, Okla 2572, 2573, 2574, 9429, 10741; Beeleigh, Okla 10752; Tamborine, Okla 10767; Dayboro, Okla 10768; Keppel Point, Okla 10861; Bajool, Okla 10878; Eton, Okla 10896; Nebo, Okla 10897; Mackay, Okla 10919; Allora, Okla 10952; Warwick, Okla 4594; Without locality, Okla. 4610, 5640, 6140; Maryvale, Lazarides 4623 (K);

Maranoa, Blake 10846 (K); Warrego, Blake 5541 (K). Capitol territory; Canberra, Okla 8135, 8137.

DICHANTHIUM SETOSUM S. T. Blake

Dichanthium setosum S. T. Blake, Queensl. Univ. Dept. Biol. Papers 2:50, 1944.

Annual or perennial; erect, culms slender, up to 70 cm. tall. Leaf-sheaths glabrous except at the often bearded nodes; leaf-blades up to 15 cm. long, glabrous or pilose with long hairs. Racemes 1-2 rarely 3, sessile or subsessile, white villous.

Sessile spikelets elliptical-oblong, truncate at the apex, 5-6 mm. long, lower 1-3 male and awnless, upper one bisexual. Lower glume pilose below the middle, with long bulbous-based hairs along the keels forming a transverse fringe near the apex; upper glume longer than the lower, scabrous on the nerves. Lemma of lower floret hyaline and empty; of upper bisexual floret forming the hyaline base of a well developed awn; anthers 3. Pedicellate spikelets male, narrowly elliptical, 5-6 mm. long, hirsute with long bulbous-based hairs along the margins forming a transverse subapical fringe, awnless or sometimes shortly awned.

Closely related to *D. sericeum*, but differs from the species in the better developed pedicellate spikelets and the distinctly larger sessile spikelets.

Distribution: Australia; New South Wales, mainly on the northern Tableland.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: Australia, New South Wales; Guyra, McKie 310 (BRI; NSW).

REPRESENTATIVE SPECIMENS: AUSTRALIA: New South Wales; Warialda, Okla 7784, 7865. Queensland; Ipswich, Okla 10769; Eton, Okla 10895; Nebo, Okla 10898.

DICHANTHIUM SUPERCILIATUM (Hack.) A. Camus

Dichanthium superciliatum (Hack.) A. Camus, Bull. Mus. Hist. Nat. Paris 27:550. 1921.

A: *superciliatus* Hack. in Engler Bot. Jahrb. 6:239. 1895.

A. *sericeus* var. *polystachyus* Benth., Fl. Austr. 7:530. 1878.

Annual or perennial; culms erect, up to 100 cm. tall. Leaf-sheath usually ciliate along one margin and at the bearded nodes; leaf-blades glabrous except at the base, up to 20 cm. long. Racemes 10 - many, sessile or subsessile, digitately arranged on a very short primary axis.

Sessile spikelets elliptical-oblong, 4-5 mm. long, lower 1-3 neuter, awnless, upper ones bisexual. Lower glume very obtuse, shortly hairy below the middle with long bulbous-based hairs along the margins, forming a subapical transverse fringe; upper glume as long as the lower, glabrous. Lemma of lower floret hyaline, forming the base of a well developed awn, anthers 3. Pedicellate spikelets larger than the sessile ones, 5 - 5.5 mm. long, neuter long ciliate, awnless.

This species is closely allied to *D. humilius*, *D. sericeum* and *D. setosum*, however, they are genetically almost completely isolated from each other (de Wet and Singh, 1964).

Distribution: Australia; widely distributed in the more tropical northern and eastern coastal regions.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: Timor; *Hackel Herbarium*. Type not seen.

REPRESENTATIVE SPECIMENS: AUSTRALIA: Northern Territory; Without locality, *Okla* 6528; Katherine, *Okla* 7861. Queensland; Townsville, *Okla* 10782; Rockhampton *Okla* 10879; Sarina, *Okla* 10894; Mt. Ossa, *Okla* 10916; Ayr, *Okla* 10907.

DICHANTHIUM TENUE (R. Br.) A. Camus

Dichanthium tenue (R. Br.) A. Camus, Bull. Mus. Hist. Nat. Paris 27:549. 1921.

Andropogon tenuis R. Br., Prod. Fl. Nov. Holl. 1:201. 1810.

Dichanthium affine (R. Br.) A. Camus, Bull. Mus. Hist. Nat. Paris 27:549. 1921.

This species was based on Hackel's concept of *Andropogon affinis* R. Br., and not on the type which belongs with *Dichanthium sericeum*.

Perennial; culms erect, slender, up to 70 cm. tall. Leaf-sheaths glabrous except at the bearded nodes; ligule a ciliate membrane; leaf-blades up to 10 cm. long, glabrous except at the base. Inflorescence on a slender peduncle, racemes 1-3, digitate, sessile or subsessile, simple; rachis and pedicels ciliate.

Sessile spikelets elliptical-oblong, 4-6 mm. long, lowest 1-3 neuter and awnless, upper ones bisexual. Glumes subequal; lower glume obtuse, sometimes abruptly 2-lobed, scabrous on the nerves and keels, otherwise glabrous; upper glume equalling the lower in length, glabrous. Lemma of lower floret hyaline and empty; of upper, bisexual floret, forming the base of a well developed awn, anthers 3. Pedicellate spikelets male, about 6 mm. long, glabrous, awnless.

Distribution: Australia, coastal region of Queensland and northern New South Wales.

Cytology: Sexually reproducing diploid ($2n = 20$).

Type locality: Australia, Queensland, Keppel Bay; *R. Brown* 6181 (BM).

REPRESENTATIVE SPECIMENS: AUSTRALIA: Queensland; Keppel Bay, *Okla* 10947, 10948, 10949, New South Wales: Guyra District, *McKie* 4 1937 (NSW).

DISCUSSION

The genetic affinities of polyploid *Dichanthium* species were discussed by de Wet and Richardson (1936), and the relationship between the diploids were studied by de Wet and Sign (1964). The extent of hybridization attempts between species is indicated in Fig. 1. Hybrids were easily produced between varieties within *D. annulatum* and within *D. caricosum*. Diploid races of the species *D. annulatum*, *D. aristatum* and *D. caricosum* crossed readily with tetraploid races of the same species to produce vigorous but completely sterile hybrids. Diploid *D. aristatum* and *D. caricosum* were also crossed with *D. annulatum*, but the hybrids were hardly viable and survived to produce flowers only with the utmost of care. At the tetraploid level *D. annulatum* and *D. aristatum* were both crossed with *D. caricosum*, and the hybrids reproduced apomictically. Attempted crosses between the first mentioned two species always failed. Because these three species are genetically isolated from each other at the diploid level, and because they only rarely cross with each other in nature, they are treated as separate species. The only other interspecific hybrid produced was between the diploid *D. panchganiense* and tetraploid *D. annulatum*. This hybrid was vigorous but completely sterile.

Chromosome homology is difficult to study in the genus *Dichanthium*. Interspecific hybridity did not severely effect chromosome pairing. The chromosomes in the hybrids usually paired preferentially within genomes derived from each parental species. Even triploid hybrids were usually characterized by essentially normal bivalent formation (de Wet et al., 1961; Chheda and Harlan, 1962). For this reason species limits were determined on the basis of morphological discontinuities correlated with degree of genetic isolation under experimental conditions.

The diploid species are phylogenetic relicts, or associated with polyploid complexes. The relict diploids *D. armatum*, *D. maccanui* and *D. panchganiense* are narrowly endemic on rocky table lands in Western India (Harlan, 1963). Within their ecological niches these species are often abundant, but never successfully invade adjacent habitats. Survival is dependent on the availability of their specialized adaptations, and chances for further speciation seem limited. They are closely allied morphologically, genetically isolated from each other

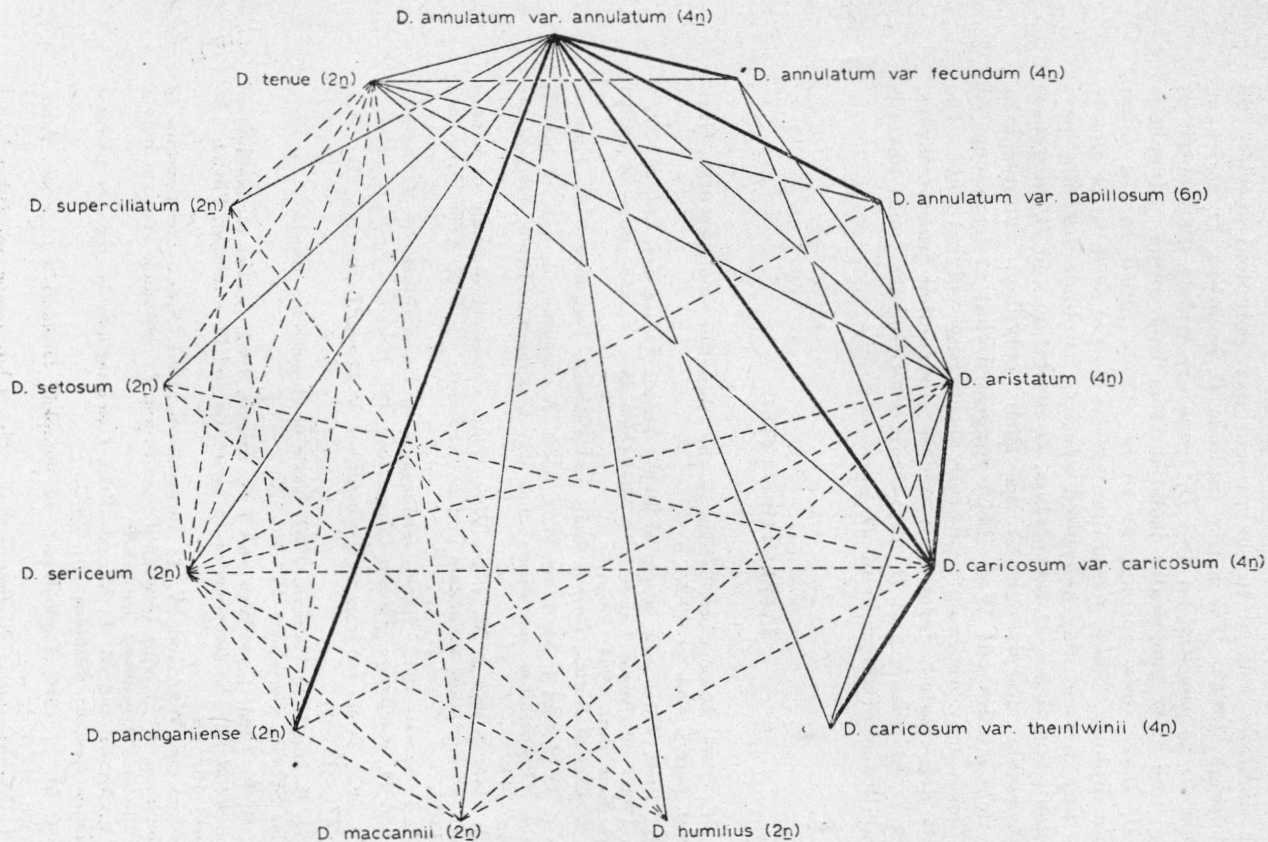


Figure 1. Hybridization range among species and varieties of *Dichanthium* section *Dichanthium*.

Heavy solid lines indicate successful hybrids; thin solid lines indicate that pollen of the one species can induce apomictic seedset in polyploid agamospecies; broken lines indicate attempted crosses, using both connected species in turn as female parent.

and only distantly related to the present day polyploid species (de Wet and Singh, 1964). The active diploids *D. humilius*, *D. sericeum*, *D. setosum*, *D. superciliatum* and *D. tenue* are widely distributed in Australia, and now genetically isolated from each other. Morphologically, *D. tenue* does not appear to be closely allied to the other Australian diploids. These Australian species do not seem to be closely allied to any present day polyploid species. Diploids forming part of the agamic complexes, *D. annulatum*, *D. aristatum* and *D. caricosum* are as variable morphologically as their polyploid counterparts. Cytogenetical studies (de Wet, 1965) suggested that at least some of these diploids may represent naturally occurring polyhaploids. The polyploids are related, forming a widely distributed weed complex, with both *D. aristatum* and *D. annulatum* contributing genes towards the variability characteristic of *D. caricosum*.

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