STUDIES ON THE MORPHOLOGY AND ECOLOGY OF THREE SPECIES OF *DICHANTHIUM* WILLEMET.

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INTRODUCTION

THE genus *Dichanthium* Willemet belongs to the tribe *Andropogoneæ* of sub-family *Panicoideæ*. It is characterised by (i) having different sexes in each pair of spikelets which also differ in shape and size; (ii) the awnless pedicelled spikelet is male or neutral; (iii) the sessile spikelets of lower and upper 1–3 pairs are male or neutral, and awnless; (iv) the lower glume of sessile spikelet is broad; (v) the spikelets are arranged in imbricate orde; and (vi) the racemes are digitate.

Haines (1924) has recorded 3 species of the genus, *viz.*, *D. annulatum* Stapf (Syn. *Andropogon annulatus* Forsk.), *D. caricosum* A. Camus (Syn. *Andropogon caricosus* L.), and *D. Clarkei* Haines (Syn. *Andropogon Clarkei* Hack.). The last named is an annual. Four other species besides the first 2 have been recorded from Bombay by Blatter and McCann (1935). These are *D. panchganiense* Blatter and McCann, *D. armatum* Blatter and McCann, *D. McCannii* Blatter and *D. serrafalcoides* Blatter and McCann.

Linnæus (as quoted by Haines, 1924) described *Andropogon caricosus* L. (*D. caricosum*) with solitary spike, and Willdenow has said 'leaves with sparse hairs and sheaths hirsute at base'.

Haines (1924) has further described a robust variety of *D. caricosum*, *i.e.*, var. *mollicomus* based on *Andropogon caricosum* L. var. *mollicomus* Hack. This variety is considered to be the same as *Dichanthium nodosum* Willemet by Fischer in Gamble's *Flora of the Presidency of Madras* (1934).

Collections of species of *Dichanthium* from Sagar were identified at the Forest Research Institute, Dehra Dun, as *D. annulatum* Stapf, *D. caricosum* A. Camus and *D. nodosum* Willemet. The description of Haines (1924) for *D. caricosum* A. Camus tallies with the stunted plants of the species in our region. The plants of this species have 1 or 2 spikes in over-grazed and dry areas. The species grows in robust form (upto 7–8 ft. high) in reserved grasslands, and in association with shrubs in gardens and cultivated fields where they get a regular supply of water all the year round. The other species, *i.e.*, *D. annulatum* Stapf seems to be much drought-resistant.

In view of certain variations observed in these species, it is not out of place to quote the following remark of Burns, Kulkarni and Godbole (1925):

"One fact we are convinced that both species, and especially *A. annulatum* are variable. It seems to us that throughout the whole science of taxonomy it is now time that the practice of naming varieties and species from casually collected specimen, dried and pressed, should be stopped, and that the only scientific method of pure culture should be substituted."

The present study includes the morphology and ecology of *Dichanthium annulatum* Stapf, and *Dichanthium caricosum* A. Camus. together with culture experiments with *D. caricosum* A. Camus, in light of the abovementioned observations.

MORPHOLOGY

Dichanthium annulatum Stapf.

Roots: Extensive, spreading and going down upto 2 ft. Secondary roots are given off from the nodes of the branches trailing over the ground. *Stems*: Tufted, perennial, with rhizomiferous main stem. Branches arise from procumbent base or ascending from a geniculating base, 1–3 ft. high, occasionally rooting at the nodes. Nodes are purple and mostly bearded. Hairs loosely tufted, longer than the length of node. Internodes compressed, groved on the surface corresponding to the back of the sheaths and pale or purplish in colour. *Leaves*: Linear, narrow, with rounded base, acuminate, sparsely hairy, upper surface having tubercle-based hairs. Leaf-blade somewhat rigid. Leaf-sheath glabrous, sometimes with ciliate margins, shining green or purplish in colour. Ligule, short, membranous, truncate, 1·5 by 1·5 mm. (Fig. 1). *Spikes*: The spikes are sub-digitate, 1–15 in number, erect or slightly spreading, pale when young and purplish or brown when old. The spikes vary in length from 1 to 2 in., sometimes branching; the stalk of the racemes is long, smooth, slender, very shining and mostly pinkish in colour. Rachis of the racemes many jointed; joints of the rachis and pedicels 1·5 to 3 mm. The peduncle of the spikes is 3 to 5 mm. long, thin, slender, shining, pinkish in colour, with a swollen base. Base, groved, glabrous or with a ring of hairs (*see* Fig. 7). *Spikelets*: Spikelets are in pairs of one sessile and one pedicelled, sub-imbricating on the rachis. Both spikelets are nearly equal in length.

Sessile spikelets: With a thick callus shortly bearded, hermaphrodite, 3–4 mm. long, ovate-oblong, compressed, dorsally awned. Awns absent in the basal and terminal few homogeneous spikelets. Lower glume is papyraceous, 3-4 mm. long, narrow lanceolate, obtuse or hardly truncate, 5–10 keeled, margins infolded. Marginal keel spinulous ciliate. The rest with spreading hairs. Hairs near the margins of the upper portion of the glume are as long as the glume, and have large orange-shaped bases; tubercles yellow in colour. The back of the glume is very shortly and scantily villous. The margins narrowly clasp the upper glume. Upper glume is hyaline, lanceolate, 3–4 mm. long, 3 keeled, depressed at the middle keel. The glume has acute apex, entire margins and is glabrous. Glume iii is hyaline, nerveless, very much shorter than the upper glume.

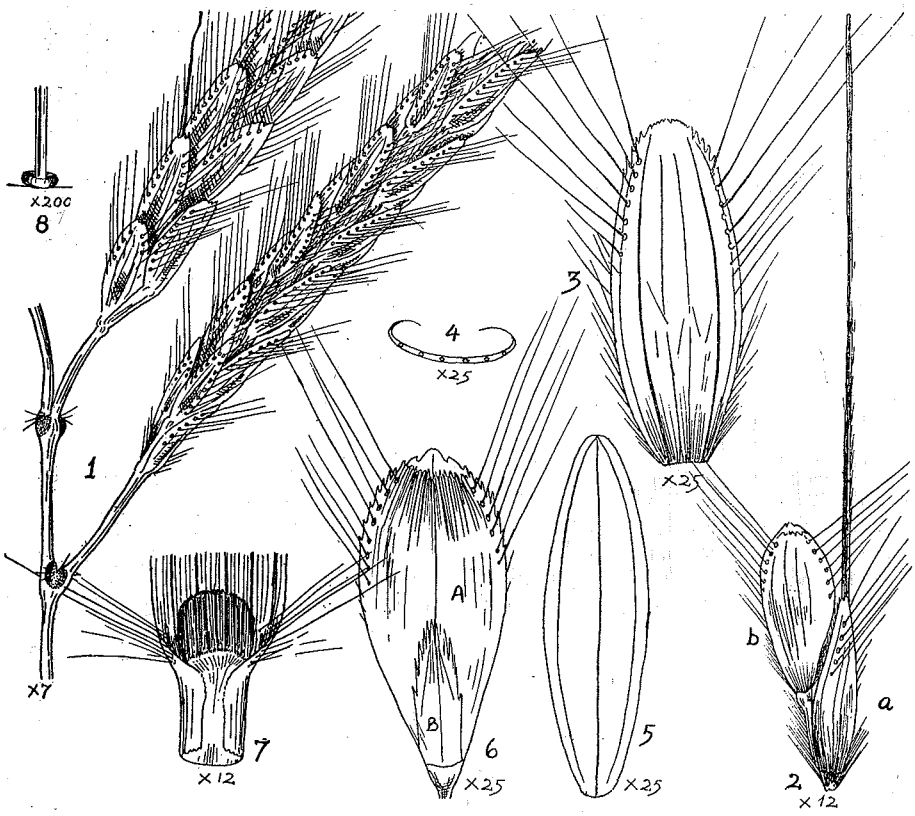

FIG. 1. *Dichanthium annulatum* Stapf—1. A portion of raceme. Observe the loose imbricate fittings of spikelets on spike. 2. A pair of spikelet. *a*, sessile, awned; *b*, Pedicellete. 3. Lower glume of sessile spikelet. 4. A cross-section of the lower glume of sessile spikelet showing the infolds of margins and position of nerves. 5. Upper glume, 3 nerved, hyaline. 6. Pedicelled spikelet. A—Lower glume; B—Upper glume. 7. Ligule of leaf. 8. Tubercular-base of the hair of glumes.

The awn emerges with a hyaline base from below the dorsal side of the ovary, 2–2·5 cm. long, column scabrid. Ovary glabrous; caryopsis obovate, flat dorsally. Pedicelled spikelets are male and awnless. The pedicel is equal to or slightly longer than half the length of the sessile spikelet. Lower glume is obovate with a mucronate base, margins infolded, with long tubercle based hairs throughout, more along the margins. Upper glume is generally small, 3-nerved, margins ciliate. Glume iii—is stout, and hyaline. Stamens are 3 with purple-dotted green anthers.

Dichanthium caricosum A. Camus

Roots: as in *D. annulatum* Stapf. *Stems*: are erect or ascending from a creeping base, rooting at the nodes. Culms 20 to 80 cm.

Stem upto 1·5 metres tall, when erect in association with shrubs. Nodes villous or mostly glabrous. Hairs, half the length of the node closely tufted. (The villous nodes were mostly found in plants from grazed grasslands.) Stem pale to greenish-purplish. *Leaves*: Leaf-blade rigid, narrowly linear, 15–50 cm. long by 2·5–7 mm. broad, glabrous, margins scaberulous, median nerved and white above. Base with a few small hairs. Leaf-sheath glabrous, margins mostly smooth. Ligule membranous, 0·35 by 1·5 mm., slightly truncate apex (Fig. 2).

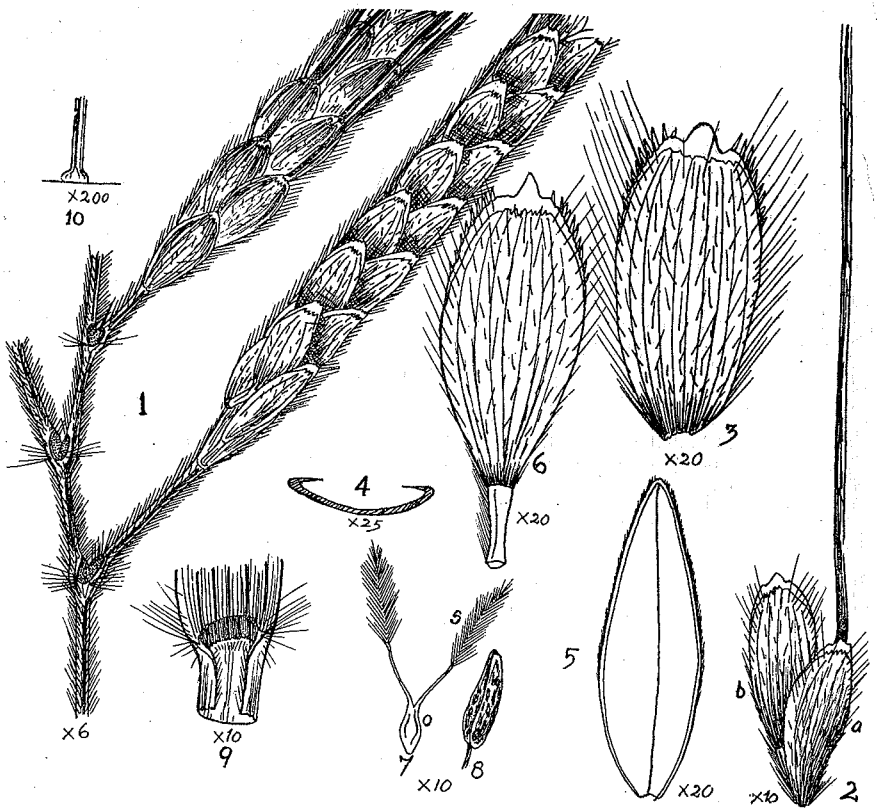

FIG. 2. *Dichanthium caricosum* A. Camus.—1. Portion of raceme. Mark the close imbricate fittings of spikelets. 2. A pair of spikelets. *a*, Sessile; *b*, Pedicillate. 3. Lower glume of sessile spikelet. 4. Cross-section of sessile spikelet showing the margins. 5. Upper glume of sessile spikelet. Similar is the upper glume of pedicelled spikelet. 6. Pedicelled spikelet-lower glume. 7. Ovary (*O*) and stigma (*S*), bifid-feathery. 8. Anther-lobes spotted. 9. Ligule of the leaf. 10. Inverted cup-shaped base of the hairs of glumes.

Spikes: 1 to few (upto 5 were recorded) variable in length from 3·75–8·75 cm. Racemes pale to greenish pink in colour. Swollen base of the rhachis, the peduncle and the internodes between the joints of successive spikes clothed with fine silky hairs (*see* Fig. 8). *Sessile spikelets*: closely imbricate; hermaphrodite. Lower and upper few

spikelets male or neutral and awnless. Spikelets dorsally compressed. Callous rounded and glabrous. Lower glume obovate or obovate-oblong, 3–5 mm. by 1·5–3 mm., apex 3-toothed. Keels 10–13, not reaching the apex. Glume pink to crimson in colour near the tip. Margins inflexed. Back hairy; hairs very small and woolly, with inverted cup-shaped base. Below the middle the glume is sparsely hairy. Upper glume—thin papyraceous, ovate or obovate being clasped by the margins of the lower glume. Keels—3, margins sparsely ciliate. Glume iii—hyaline, small, nerveless and shining. Scaberulous awn 2–2·5 cm. long. *Pedicelled spikelet*: male or neutral. Pedicels much shorter than half the length of sessile spikelet. Lower glume 10–15 nerved, margins scabrid; obovoid or oblong. Hairs small, on the upper side of the glume, margins broadly infolded. Upper glume, membranous, about equal to the first glume; nerves—3, margins ciliate and infolded. Glume iii—small, hyaline, nerveless, linear, small, apex narrowed and deeply bifid. There are 3 stamens as in the former species.

Blatter and McCann (1935) have distinguished *D. caricosum* A. Camus and *D. annulatum* Stapf, on the basis of 4 characters, *viz.*, (1) Habit, (2) Nodal hairs on stem, (3) Colour of inflorescence, and (4) Hairs on inflorescence. In addition to these the 2 species can be distinguished in the field by the following characters arranged in sequence of prominence.

TABLE I

Distinguishing Characters in the Morphology of Dichanthium annulatum Stapf and Dichanthium caricosum *A. Camus*

No.	*D. annulatum* Stapf	*D. caricosum* A. Camus
1	Joints and nodes of the peduncle glabrous or sparsely hairy.	Peduncle including its nodes finely white-woolly, always.
2	Spikelets arranged in sub-imbricate (loose) order.	Spikelets closely imbricated.
3	Spikes 1 to 15 in number, pinkish or dark-red in colour.	Spikes 1 to 5 in number, pale or olive green to greenish-pink.
4	Long (longer than the total length of the lower glume) yellow tubercular based hairs on the lower glumes of both the spikelets. The hairs are generally present on the upper half of the glume.	Hairs short and tufted-silky. Somewhat uniformly studded throughout the upper surfaces of the lower glumes of both the spikelets.
5	Pedicels of the ped. spikelets equal or slightly longer than half the length of sessile spikelets.	Pedicels of the pedicelled spikelets much smaller in length than half the length of the sessile spikelets.
6	Nodes always villous with long hairs.	Nodes mostly glabrous; young branches generally with villous nodes.
7	Ligule 1·5 by 1·5 mm. with truncate apex.	Ligule 0·35 by 1·5 mm. with slightly truncate apex.

VARIABILITIES OF *D. caricosum* A. Camus

In Table II are given the descriptions as given in different floras for *D. caricosum* A. Camus.; var. *mollicomus* Hack.; and *D. nodosum* Willem. From the descriptions, it is clear that the species is much variable with regard to shape and size. It is also seen from the table that *D. caricosum* var. *mollicomus* Hack. is identical with *D. nodosum* Willem.

TABLE II

Author's name	*D. caricosum* A. Camus (Syn. *A. caricosus* L.)	*D. caricosum* var.– *mollicomus* Hack.	*D. nodosum* Willem.
Haines (1924) p. 1039	*Stem:* 1–2 ft. *Leaves:* 2–5″ (5–12·5 cm.) by 0·1–0·15″ (3–5 cm.)– ("sometimes larger outside our area"). *Spikes:* 1–4. Sessile spikelets-callous glabrous, Gl. i: 0·14–0·15″ (4–5 mm.) denticulate at tip. Tip 2 toothed. 5–7 nerved between 2 keels. Gl. ii : 3 keeled. Joints and pedicels 0·04–0·05″ (1–2 mm.) villous one side. Pedicelled spikelet : 0·15″ (5 mm.) Gl. i : 11 nerved, laxly hairy. Gl. ii—margins inflexed.	This appears to be more distinct. A specimen collected from Bilaspur is a very robust plant with 3–4 broad spikes, upto 3″ (8 cm.) long and 0·15″ (4–5 mm) wide. Very hairy peduncles and toothed bidentate winged broad glume-i. The nodes are pubescent.	
Hooker (1897) Vol. vii, p. 196	*Stem* : 1–2 ft. *Leaves:* 6–8 by 0·1–0·25″ (15–20 cm. by 3–8 mm.) Spikes : ⅛–¼″ (4–10 mm.). Joints and pedicels ⅓ of the spikelets. Sessile spikelets : 5–7 nerved, Gl. ii : 3 keeled. Pedicelled spikelets smaller than the sessile one. A very variable grass.	*Stem:* pubescent below the spikes. Gl. i–3 toothed, hairy all over.	Synonymous to var. *mollicomus*, also syn. *Dichanthium nodosum* Ustri, Annals XVIII (1796), Syn., *Andropogon mollicomus* Kunth Revis.
Bor (1941) p. 118	*Culms:* 30–60 mm. *Leaves:* 15–20 cm. by 2·5–5 mm. Inflorescence: solitary or subdigitate 2–4 nate, 2·5–10 cm. long. Joints and pedicels 1·3–1·6 mm. Sessile spikelets: 4–5 mm. long. Gl. i : ciliate. Gl. ii : longer than the sessile spikelets.	not mentioned	

D. caricosum A. Camus seems to be less drought-resistant. It shows stunted growth on sandy soil of poor moisture content. In summers, in overgrazed grasslands also, it shows stunted growth having as few as one spike per peduncle. In culture with favourable moisture supply the depauperate forms collected from these regions, grow into

normal plants. Conversely the seeds of the robust variety can be grown into stunted plants on poor dry soils.

In view of the abovementioned observations the following study was made:

Ten localities were chosen on the basis of soil moisture content for a study of the species. The data obtained were: height of the culms standing erect from the prostrate base; average number of spike per raceme; average number of spikelets per spike; length and breadth of lower glume of sessile spikelets and colour of the spike. The observations have been correlated with the usual factors of soil-water and biotic operations. The results are given in Table III.

TABLE III

Morphological Characters of the Plants of D. caricosum *A. Camus from Different Localities*

Date: March 1952

	Locality	Soil-water in % of dry wt.	Aver. height of plants	Aver. No. of spikes per raceme	Aver. No. of spikelets per spike	Length of Gl. i. of sessile spkt. in mm.	Breadth of Gl. i. of sessile spkt. in mm.	Colour of spikes	Remarks
1	Along water drains supplying water to crop fields in University gardens and farm.	27·42	52 cm.	2 3 4 2 3	34 46 46 32 38	3·5 4 4 3·7 3·7	1·7 1·8 1·8 1·8 1·8	Greenish brown	No grazing
2	Crop fields, University gardens and farm.	9·64	75	2 3 3 2 4	32 40 30 34 40	3·7 3·9 3·6 3·6 3·8	1·8 1·8 1·7 1·7 1·8	Purplish green	No grazing
3	Crop fields, Makronia village.	8·30	75	4 3 2 1 2	64 48 36 28 32	4·2 4·0 3·8 3·7 3·7	2·0 2·0 1·8 1·7 1·7	Purplish green	Very mild grazing
4	University Botanical Gardens.	8·05	75	3 3 3 4 4	36 36 44 44 40	3·7 3·7 3·9 4·0 3·8	1·7 1·7 1·9 1·9 1·8	Purplish green	No grazing and no cutting
5	Lime-rich soil on open slope.	2·55	20	1 2 2 1 1	18 20 22 18 18	3·4 3·4 3·4 3·5 3·4	1·6 1·6 1·6 1·7 1·7	Purple	Severe grazing

TABLE III—(*Contd.*)

	Locality	Soil-water in % of dry wt.	Aver. height of plants	Aver. No. of spikes per raceme	Aver. No. of spikelets per spike	Length of Gl. i. of sessile spkt. in mm.	Breadth of Gl. i. of sessile spkt. in mm.	Colour of spikes	Remarks
6	Enclosure area in University Botanical Gardens.	11·83	105	4 4 3 3 4	48 50 54 48 48	4·0 4·0 4·2 4·0 3·9	1·8 1·8 2 1·8 1·8	Greenish brown	No grazing and no cutting
7	Along high hedges in the University Botanical Gardens.	10·23	2 metres	4 4 3 3 3	60 60 54 54 52	4·2 4·2 4 4 4	2·0 2·0 1·9 2·0 2·0	Greenish brown	No grazing and no cutting
8	University grounds (open-plateau)	3·79	24	1 2 1 1 1	30 36 44 34 28	3·5 3·7 3·7 3·7 3·5	1·7 1·8 1·8 1·8 1·7	Purple	Severe grazing
9	Plateau of Gambheria village.	5·66	32	2 2 2 2 2	36 36 38 32 36	3·7 3·7 3·7 3·5 3·7	1·8 1·8 1·8 1·7 1·8	Greenish purple	Severe grazing
10	University grounds—open slopes.	6·45	32	4 1 2 3 2	42 36 38 40 38	3·8 3·7 3·7 3·8 3·7	1·8 1·7 1·8 1·8 1·8	Greenish purple	Occasional grazing

Correlation of plant growth with the habitat factors is always a difficult study, as there is never a single factor working exclusively. A number of environmental factors usually work at a time of which some may be more dominating. However, in the present case we may put that primarily the growth of this species depends upon a good supply of available water and also upon less of biotic disturbance.

Effects of grazing and drought upon the plant can be observed from Table III and Fig. 3, as follows:—

Morphological features: Reduced size of erect stem ; reduction in the number of spikes per raceme; reduction in the number of spikelets per spike; and reduction in the length and breadth of lower glume of spikelets.

Physiological: Development of red pigments, and initiation of early flowering.

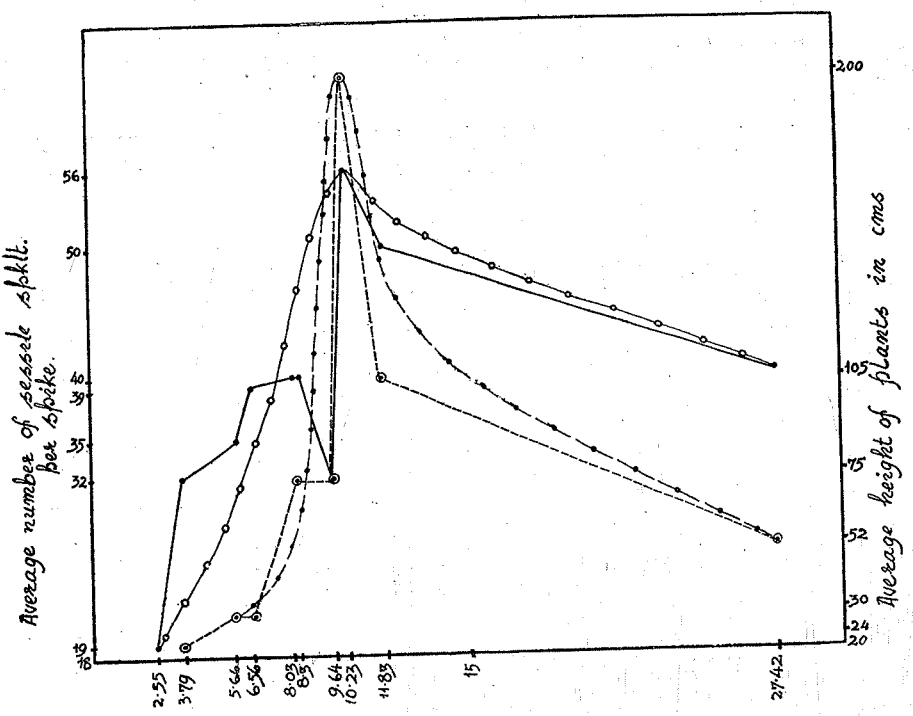

FIG. 3. Soil-water in % of dry wt. of soil from different habitats as given in Table III.

Apart from the abovementioned characteristics the following points are worth noting:—

(i) Comparing the readings from the localities 1 and 2 (*cf.* Table III) it seems that a further increase in the percentage of available water in the soils brings an overall dwarfening of the plants.

(ii) Again, from the readings for the localities 6 and 7 of Table III, it is seen that the plants attain a height of even 2 meters. Probably in this case the overgrowing hedges provide support to the weak and thin stem growing under shade.

CULTURAL EXPERIMENTS

Cultural experiments were undertaken, in the month of March, 1951, in order to confirm the variabilities of *D. caricosum* A. Camus. Plants with stunted growth having little foliage and mostly with one spiked racemes were brought from grazed areas. A few plants were also transplanted from a patch having heavy interspecific competition. These plants were put in plots of sandy loam under fence in the Botanical Gardens 8 inches apart from each other. The plots were watered on alternate days, and no fertiliser or manure was supplied. The following readings were taken after 1 year, in the month of February, 1952.

TABLE IV

(1) *Characters of Original* D. caricosum *A. Camus Plants Before the Transplantation*

Locality	Condition of growth	Height of plants in cm.	Length of internodes in cm.	No. of Racemes	Aver. No. of spikes per raceme	Length of spikes in cm.	No. of sessile spkts.	Length of Gl. i of sessile spkt. in mm.	Breadth of Gl. i of sessile spkt. in mm.	Aver. length of leaf in cm.
1 Crop fields University grounds	Under heavy interspecific competition	80	15·8	21	1	4·1	26	3·7	1·6	11·5
2 Botanical Gardens	Occasional cutting	35	10·5	8	2	6·4	34	3·8	1·8	17·5
3 Open lime rich slope	Under severe grazing	15	4·6	1	1	3·1	18	3·4	1·6	5·4
4 University plateau	Under severe grazing	20	4·4	2	1	3·8	26	3·7	1·7	6·5
5 do	do	15	4·0	2	1	3·6	22	3·5	1·7	6·3

(2) *Measurements for an average plant after one year of Controlled Growth*

Date: February, 1952

Culture plant. No cutting, no grazing and no manuring. Watered on alternate days	95	11·5	16	3	7·6	56	4·0	1·8	19·0

A polygraph (Fig. 4) has been drawn to designate the growth of *D. caricosum* A. Camus as found in localities 1, 3 and 4 (of Table IV) before the culture experiments and the resultant growth after 1 year of controlled development.

It is seen that diagrams 'HLSGH' and 'hlsgh' are much similar in shape.

It is found that the lengths of the leaf and the spike are correlated in growth as shown in Fig. 5. The data so plotted are taken from Table IV (for points 'a' and 'b'). Points 'c' have been put for the spike-leaf relation of a number of robust plants, as found in nature. The variations are, therefore, continuous and belong to a uniform population of the species.

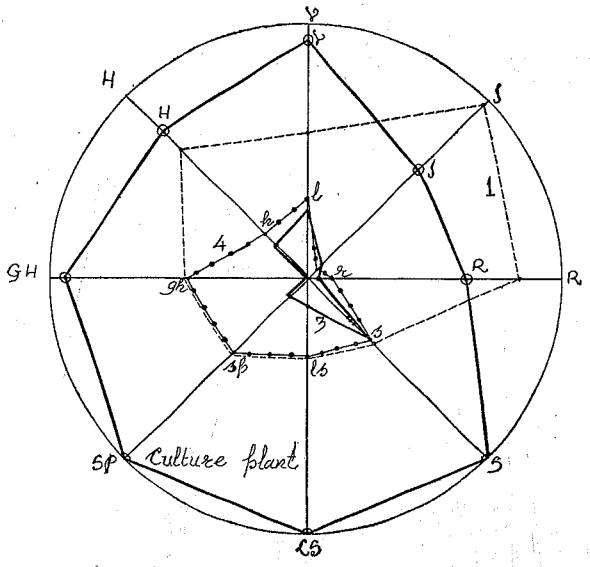

FIG. 4. Polygraph for the size and shape of the plants from localities 1, 3 and 4 (*cf.* Table IV) before the culture experiment and of a plant after one year of culture experiment of *Dichanthium caricosum* A. Camus (*H*, Height of plants; *L*, Average length of leaf; *I*, Length of internode; *R*, Number of racemes; *S*, Average number of spikes per raceme; *LS*, Length of spikes; *SP*, Number of sessile spikelets; *GH*, Length of glume I of sessile spikelet; and *GB*, Breadth of Glume II of sessile spikelet).

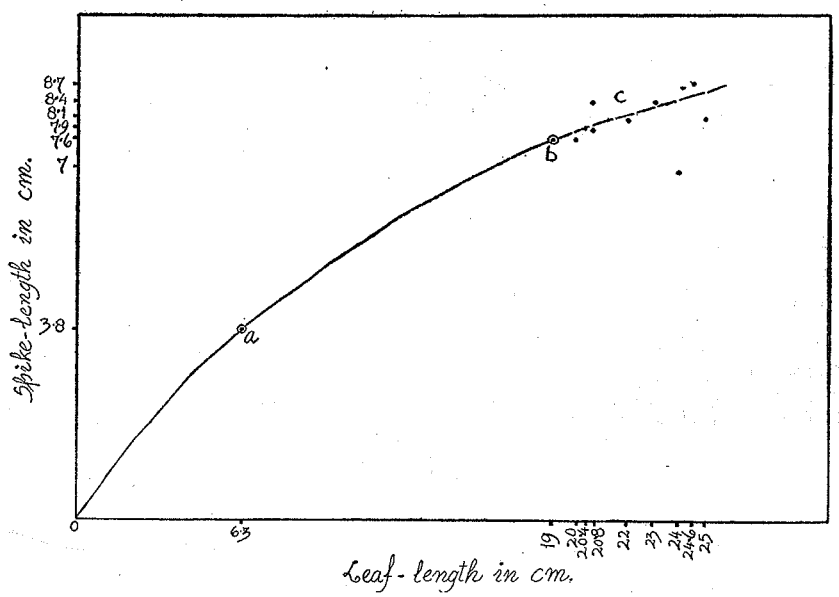

FIG. 5. Leaf-spike relation of *D. caricosum* A. Camus.

DISTRIBUTION

D. caricosum A. Camus and *D. annulatum* Stapf are fairly well distributed in India. According to Hooker (1897) *D. caricosum* A. Camus is distributed on plains and low hills of India from Scind to Burma, and the Andaman Islands (not in N.W. India) and southwards to Ceylon. The species is further distributed in Mauritius and China. In Bihar and Orissa, Haines (1924) reports its frequent occurrence in a number of places. Its presence is reported on the Banks of Brahmaputra and in Lakhimpur in Assam by Bor (1936). Bor (1941) in 'U.P. grasses' shows its distribution in South Kheri Bundelkhand and elsewhere in the plains. In South-India, Achariyar and Mudaliyar (1921) write that it is less common than *D. annulatum* Stapf. They report that it grows upto 4–5 ft. in black cotton soil in Bellary District. Describing the grasslands of Gujerat, Deccan, Southern India and Bombay, Burns, Kulkarni and Godbole (1925) have described both the species of *Dichanthium* to be amongst few more important grasses.

The following map showing the distribution of both the species of *Dichanthium* is based upon records available in literature (Fig. 6).

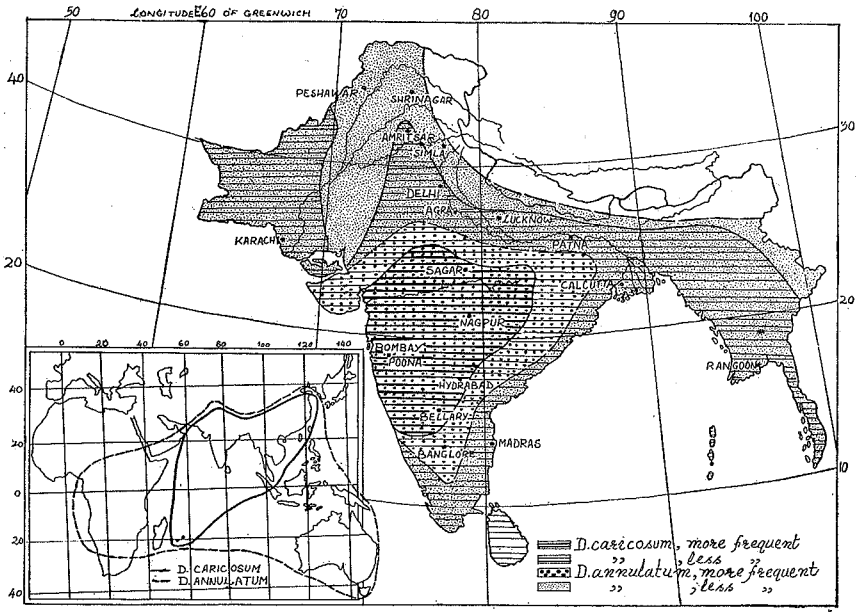

FIG. 6. Distribution of *D. caricosum* and *D. annulatum* in India, Burma, Pakistan and elsewhere.

D. annulatum Stapf is distributed throughout the hills and plains of India, from Kashmir westward to Bengal and southward (not in Ceylon). Hooker (1897) further describes its distribution in Trop. Africa, China, Australia and Pacific. Bor (1941) has shown its occurrence

in almost all the districts of U.P. and Assam. The author has noted its presence on the 'Jakku' peaks in Simla (about 8,000 ft. above sea level), although the grass was in much stunted growth.

Ecology

1. *Duration.*—Both *D. annulatum* Stapf and *D. caricosum* A. Camus are perennial. The species in open grasslands* pass over the hot dry season as dormant stumps. There is always present a cushion of old leaves at the base. The perennating organ in the 2 species is stolon (underground rhizome); this is more conspicuous in case of *D. annulatum* Stapf.

Unlike *D. caricosum* A. Camus, *D. annulatum* Stapf never dries completely and one can see a few green leaves present in hot dry season.

Seeds start germinating, in nature, after a few showers in June, and by the end of July the culms attain a height of 1 ft. or so. During the first year of emergence of plants from the seeds, there is not much of vegetative growth. The racemes, too, are fewer in number. Stolon buds of the first year spread out with more vigour next year. More shoots are thus added. The stump or tuft gradually develops and acquires a 'basket-form' in both the species. As has been earlier observed *D. caricosum* A. Camus, in protected places grows much like a twiner (upto 6 to 7 ft.) in association with other shrubs.

2. *Phenology.*—In Sagar, *D. annulatum* Stapf starts flowering from November or late October and may continue so upto March or April. However, excepting the rainy season it is not infrequent to find a few plants in flowers all the year round. *D. caricosum* A. Camus flowers from end of September and lasts till March.

3. *Fruiting.*—The caryopsis of *D. caricosum*, liberated together with all the glumes, is shed singly from the spikes. The dispersal starts from the apex downward. Whereas the fruits of *D. annulatum* Stapf liberated similarly, are shed in twisted lumps of 2 to 6 seeds. The assemblage of the seeds seems to have been brought about with the help of the twisted awns and the long hairs of the glumes. In case of *D. caricosum* A. Cumus the awns are mostly shed before the fruits are mature for dispersal, and hence they do not form any lump. Whether this phenomenon is advantageous for seed dispersal cannot be said at present.

Seeing the mode of dispersal *D. annulatum* Stapf should have a patchy growth of plants in the subsequent year wheras *D. caricosum* A. Camus plants should grow uniformly distributed. However, the absence of a patchy growth of plants of *D. annulatum* Stapf cannot be accounted at present.

D. annulatum Stapf and *D. caricosum* A. Camus grow abundantly in Sagar (M.P.) on 'premature to mature soil' (Pandeya, 1952) consisting of sandy-loam with light to moderate admixture of coarse lime

* Unfenced, open to grazing.

of intertrappean origin. The soil is rich in mineral elements like iron, aluminium, calcium, magnesium, etc. Much iron, however, seems injurious to the species, since they do not grow on leached soils. Although both species seem to be calcicolous yet *D. annulatum* Stapf is probably more tolerant to lime. This species seems also to withstand waterlogging of 'not long duration'. Achariyar and Madaliyar (1921) write that the two grasses like sheltered places; and *D. caricosum* A. Camus grows in places with sufficient moisture in soil. Bor (1941) observes for *D. caricosum* A. Camus that 'it favours rather dry and sandy habitats,' and puts *D. annulatum* Stapf amongst the grasses growing in 'moderately moist places'. He further puts *D. annulatum* Stapf amongst the grasses 'most frequently found in grazing grounds'. These grasses 'maintain themselves because of their perennial and prostrate habit whereby the stem is pegged down to the soil by rootlets from the nodes'.

The presence of *D. annulatum* Stapf in Simla near Viceregal Lodge and Jakku Hills upto 8,000 ft. above sea level may show its tolerance to altitude and extreme conditions of temperature.

The usefulness of *D. annulatum* Stapf as a species for erosion control is being studied and will be discussed in another paper.

SUMMARY

The paper deals with morphology, physiology and ecology of two species of the genus *Dichanthium* Willemet, *viz.*, *D. annulatum* Stapf and *D. caricosum* A. Camus.

Both are excellent fodder grasses.

The two species are much similar in appearance. Distinctive characters differentiating the two species are given in a tabular form in the text.

Both the species are much variable with regard to shape and size of branches, leaf, spike, etc., in response to environment. *D. annulatum* Stapf seems to be more drought resistant and grows in a great variety of habitats. *D. annulatum* Stapf stands cutting well but overgrazing seems harmful to it. *D. caricosum* A. Camus is probably more sensitive to water and grows in stunted condition with overall reduction in the size of branches, leaf and spike in places with less soil-water.

On the basis of variability, morphology, culture experiments and analylical data it is observed that *D. nodosum* Willem. (Syn. *D. caricosum*-var. *mollicomus* Hack.) is an ecological form of *D. caricosum* A. Camus.

It has been shown that the same plant of *D. caricosum* A. Camus growing in sandy and less watered places with one spike per raceme if given favourable water-supply may grow into a form resembling var. *mollicomus* Hack.

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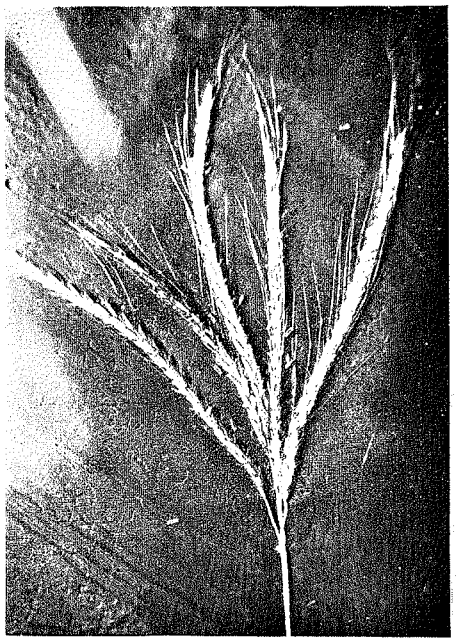

FIG. 7. Raceme of *Dichanthium annulatum* Stapf. having 4 spikes. Note the long, smooth, slender stalk of the raceme. Peduncles of the spikes are glabrous. Base of the peduncle is groved, and with a ring of hairs.

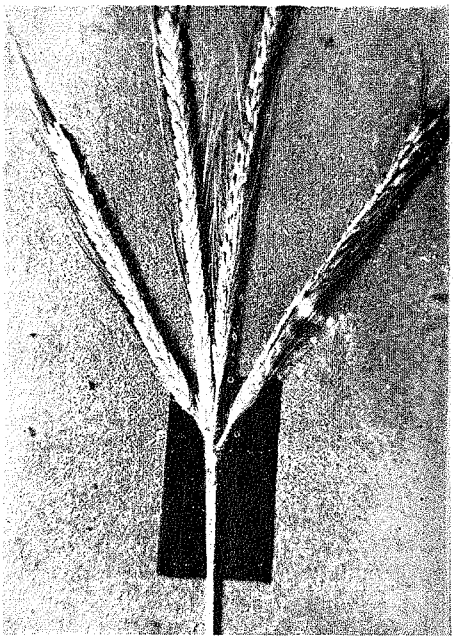

FIG. 8. Raceme of *Dichanthium caricosum* A. Camus having 4 spikes. Note the broad glumes closely fitted. Swollen base of the rachis, the peduncle and the internodes between the joints of successive spikes are clothed with silky hairs (Having the black background).