



Micromorphological study on *Carex* (L.H. Bailey) Cyperaceae in Punjab

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Abstract: The genus *Carex* is the largest in family Cyperaceae, containing over 2000 species. Members is found in different habitat types, ranging from aridity, high altitude, intense salinity, wet places, swamps, marshes and vertical slopes. Variation within the genus is extremely high, which is based on qualitative and quantitative morphological features and genetic makeup. A comprehensive study was conducted to collect plants of genera *Carex* of family Cyperaceae, throughout mountainous region (Murree, Bansra Galli, Jhinka Galli and Nathia Galli districts) in the Punjab. Macro- and micro-morphological study was conducted to record inflorescence characteristics of the genus. Macro- and micro-morphological characteristics like size and type of inflorescence, number, shape and size of bract, size, shape and color of glumes and seed characteristics were recorded. Floral morphological characteristics are of high taxonomic significance, which was an effective tool to classify different species. Habitat ecology and distributional pattern like geographical parameters have important contribute in taxonomy of this genus.

[Asma Akram, Naveed Abbas, Hira Aslam, Sahar Jameel, Mehwish Ramzan, Tahira Bano. **Micromorphological study on *Carex* (L.H. Bailey) Cyperaceae in Punjab**. *Rep Opin* 2021;13(2):39-50]. ISSN 1553-9873 (print); ISSN 2375-7205 (online). <http://www.sciencepub.net/report>. 6. doi:[10.7537/marsroj130221.06](https://doi.org/10.7537/marsroj130221.06).

Key words: Cyperaceae, *Carex*, Punjab

Introduction

The Cyperaceae family is one of the largest family of angiosperm plants. In the Monocotyledons, Cyperaceae is the third largest family and it consists of 104 genera, 5000 species. Approximately 179 species of Cyperaceae are present in Pakistan and most of them are weeds (Ball *et al.*, 2002). As indicated it is most likely the seventh biggest family around the world (Reznicek, 2016). This Cyperaceae family has almost 5,000 type of species in 80 genera and included same type of species under 104 genera (Bruhl, 2001).

This Cyperaceae family has 537 species and 92 genera of Cyperaceae and this number was later refreshed as 580 species under 39 genera (Karthikeyan, 2000). Some scientists suggested that there is 570 species of 39 genera in Pakistan and during introduce it is assessed that this family contains 580 having a place with 32 genera (Singh and Prasad, 2001). In Goa, the family is spoken to by 105 genera including 94 species, 2 sub-species under 6 genera. Cyperaceae family has grasses which are monocot angiosperm plant (Govaerts *et al.*, 2007).

These species may occur in the form of a horizontal stem without thickening, with a thickened main axis, with small internodes or sympodial growth and monopodial growth (Rodrigues and Estelita,

2002). Preliminary studies occurred on stem anatomy in Cyperaceae family (Metcalfe, 2009). Few studies exist on stem ontogenesis in this group. But among those that do exist two are highlighted (Gifford and Bayer, 2000). The underground system analyzed which shows *C. esculentus* (Rodrigues and Estelita, 2002). In monocotyledons the stems can present two thickening of meristem the primary thickening meristem and the secondary thickening meristem (Rudall, 2009).

The anatomy of branches and main axis of Cyperaceae species, do not noticed by many scientists on their development and growth of these cells and there is also no any concept of cells growth and their activity. The objective of that assignment is to publish study material on horizontal, running trailer stem and scaly stem cells and tissues to give idea more authentic about stem growth and use the existence and function of dividing cell thickness such as the maximum amount of mature cell has link with the characteristics of main axis (Ball Reznicek, 2002). Cyperaceae family has two main groups related to the *cyperus* genera. Basically four species were accepted (Simpson *et al.*, 2007). Recently both main group has been recognized

as the only two sub-families of Cyperaceae, namely Cyperoidae and Mapanioideae (Muasya *et al.*, 2009).

Inflorescence of Cyperaceae family mostly develops in the axis of a subtending bract, called glumes, with the glumes and their flower being organized (Vrijdaghs *et al.*, 2009). A cyperaceae family has been explained as a complex multiple spikelet because of the unlimited nature of the critical flowering units (Kukkonen, 2000). Bracts by working reverse the single flowers of a spikelet as explain by (Weberling, 2001). However term 'glumes' accepted for spikelet of Cyperaceae family (Vegetti, 2003). Cyperaceae spikelet and bracts are group of flowers structures, work done on both as a structural and as a metabolism unit. Therefore, a spikelet consists of a mother axis or rachis and few many helical to distichously arranged bracts, single, dioecious or monoecious flower (Goetghebeur, 2000).

The apical bracts of the main axis in florescence and bracts have also apical secondary axis in inflorescence (Vegetti, 2003). Many Cyperaceae species, however, have flowers with lateral spikelet group, in which many bracts occur in the axis of a individual bract, as in *Cyperus* (Guarise and Vegetti, 2008). Bract group mostly evolved from a kind of commencing the original primordial in the axis of the spikelet and bract, as a conclusion in series of terminal buds (Vrijdaghs *et al.*, 2003).

Carex L. is the largest genus of Cyperaceae family with the abundance of species, almost 2000 investigated by (Goetghebeur, 2000). However its species mainly distributed in North America and Africa it is well organized in South America, with almost 200 genera (Wheeler, 2002). There are yet no any concepts recorded for American species however 18 species were listed (Guaglianone *et al.* 2008). The genus *Carex* L. is cosmopolite mainly in the southern hemisphere with almost 2000 species (Reznicek, 2004). Grass species diversity of this *Carex* L. genus is abundance in the cold region of the southern Hemisphere, especially in cold climate countries and North America generation of grasses of this genus is almost few in numbers in tropical regions, such as Southern Pakistan and Eastern Africa country (Govaerts *et al.*, 2010). This *Carex* subgenus has abundance form of plant diversity in USA. Recent circulation and relation of plants with environment of *Carex* genus grow abundantly in colder areas in all over the world but this investigation is not accepted yet (Ball 2001). There is no new invention for the study of *Vignea*, however grasses occurred into two classes and orders have stamen and pistil containing flowers which have spikelet and bracts (Egorova, 2000). Mostly groups contain common ancestor which have link with their evolution. However study of

Carex show that many species of this genus are not relate to subg. *Vignea* (Starr *et al.*, 2004). Few common ancestors study on *vignea* notice all primary characters. Main link between *Carex* and *Vignea* is focused by (Yelton and Naczi, 2001). This genus has 13 grasses of *Vignea* which have no link with evolution characteristics (Hendrichs *et al.*, 2004).

Other three species has genera *Kobresia* which is also the member of genus *Vignea* and also highly supported by common ancestor. Mostly the use of genus *Kobresia* is investigated by their chemical structure because that has relation with genus *Carex* (Hendrichs *et al.*, 2003). Mostly *Vignea* accepted as a universal group by many caricologists. This structural study of all sub.genus accepted by DNA sequence tests and by its data (Roalson *et al.*, 2001). Further more than 300 years work on sub.g *Carex* we cannot properly investigate about all the groups of this genus as well as sub.g *Vignea*. However presence of dendrogram can give us morphological investigation of new grasses (Starr and Ford, 2001).

Objectives:-

- to record species diversity in genus *Carex*.
- to investigate detailed macro- and micro-morphological characteristics of the inflorescence of genus *Carex* along with its high resolution photographs.
- to record habitat ecology of the genus.

Materials And Methods

Detailed study was conducted all over the mountainous regions of district Chakwal, Jhelum, Murree and Mianwali in the Punjab for distribution ecology and macro- and micro-morphological characteristics of inflorescence of the genus *Carex* (family Cyperaceae). These all regions were widely studied for distribution records and plant material was collected for inflorescence studies and herbarium records. The inflorescences of all the collected species were preserved in FAA (Formalin Acetic Acid) solution for fixation, which contained formalin 5%, acetic acid 10%, ethyl alcohol 50% and distilled water 35%. All specimens were then transferred in acetic alcohol solution (one part acetic acid and three parts ethyl alcohol) for long-term preservation. Relative qualitative and quantitative morphological analysis was done with a dissecting microscope. Characteristics which were studied during the investigation are presented in Table 1. Photographs of the habitats were taken in the original habitats with the help of digital camera including the close view of the inflorescence. The inflorescence was scanned by hp 2100 mfp scanner. Photographs of the inflorescence were also taken under the dissecting microscope for micro-morphological studies of the inflorescence.

Table 1: Habitat description of the species of genus *Carex* (Cyperaceae) from Murree Hills

<i>Carex</i> (species)	Altitude	Longitude	Latitude	Habitat distribution
<i>Carexfedia</i>	6176	33,52,19.5	73,22,00.4	Murree Hill-forest vegetation
<i>Carexflacca</i>	6166	33, 14, 15.7	73, 28, 13.2	BansraGali-forest vegetation
<i>Carexfiliciana</i>	6164	33, 53, 20.7	73, 22,00.1	BansraGali-forest vegetation
<i>Carexremota</i>	6511	31, 15, 40.4	73, 50, 00.3	Murree Hill-forest vegetation
<i>Carexcroyleana</i>	6110	31, 53, 20.4	73, 22, 13.1	Nathia gali-forest plantation
<i>Carexcanescens</i>	6020	33, 53, 22.6	73, 21, 40.1	Murre- Hills forest vegetation
<i>Carexchitralensis</i>	6512	31, 15, 41.4	73, 50, 13.1	Murree Hill-forest vegetation
<i>Carexkaroi</i>	6110	33, 53, 20.4	73, 22, 00.3	Jhika gali-forest plantation
<i>Carexfoliosa</i>	6209	33, 57, 15.6	73, 27, 19.6	Bhurban-forest plantation
<i>Carexcruciata</i>	6177	33, 53, 20.5	73, 22, 00.3	Bansra Gali-forest vegetation
<i>Carexhaematostoma</i>	6040	33, 57, 22.6	73, 27, 41.1	Bhurban-grassy lawn
<i>Carexatrofusa</i>	6177	33, 53, 20.5	73, 22, 00.3	Bansra Gali-forest vegetation
<i>Carexdecaulescens</i>	6209	33, 57, 15.6	73, 27, 19.6	Bhurban-forest plantation
<i>Carexdivulsa</i>	6110	33, 53, 20.4	73, 22, 00.3	Murree Hill-forest plantation
<i>Carexomiana</i>	6512	31, 15, 41.4	73, 50, 13.1	Murree Hill-forest vegetation
<i>Carexplectobasis</i>	6512	31, 15, 41.4	73, 50, 13.1	Bhurban-grassy lawn
<i>Carexsanguinea</i>	6512	31, 15, 41.4	73, 50, 13.1	Murree Hill-forest vegetation
<i>Carexbrunnea</i>	6177	33, 53, 20.5	73, 22, 00.3	BansraGali-forest vegetation
<i>Carexcruenta</i>	6040	33, 57, 22.6	73, 27, 41.1	Bhurban-grassy lawn
<i>Carexlatialis</i>	6040	33, 57, 22.6	73, 27, 41.1	Murree Hill-forest vegetation
<i>Carexnubigena</i>	6209	33, 57, 15.6	73, 27, 19.6	Patriata-forest plantation
<i>Carexturkestanika</i>	6512	31, 15, 41.4	73, 50, 13.1	Murree Hill-forest vegetation
<i>Carexvulpinaris</i>	6040	33, 57, 22.6	73, 27, 41.1	Bhurban-grassy lawn

Table 2: Morphological characteristics recorded during species study.

Character	Qualitative measure	Quantitative measure (mm)
1.1: Inflorescence structure	1: Type	A: Diameter B: Length C: Bract per inflorescence
1.2: Spikelets	1: Shape 2: Color	A: Number of spike B: Length of spike C: Width of spike
1.3: Bracts		A: Num of bracts B: Length of bracts
1.4: Glumes	1: Shape (morphology) 2: Pubescence 3: Color 4: Apex shapes	A: Glumes per spikelets B: Length of Glumes C: Width of Glumes D: Glumes-like bract length E: Glumes like prophyll length
1.5: Anthers (pollens)		A: Length of Anthers
1.6: Fruits	1: Shapes (Dorsal view) 2: Shape (Ventral view) 3: Upper surface 4: Color	A: Length of fruits B: Width of fruits

Results And Discussion

Quantitative morphological characteristics

Inflorescence

Inflorescence diameter was higher in *Carex foliosa* and *Carex cruenta*. Other species such as *Carex fulciana*, *Carex karoii*, *Carex nubigena*, *Carex divulsa* and *Carex turkestanica* had also higher diameter of inflorescence than other species. All the data of these species are shown in Table (3). *Carex decaulescens* was much higher length of inflorescence. Other species such as *Carex foliosa* and *Carex cruciata* was also high inflorescence length. *Carex flacca*, *Carex royleana*, *Carex canescens*, *Carex chitralensis*, *Carex cruciata*, *Carex haematostoma*, *Carex plectobasis* and *Carex sanguinea* was minimum length of inflorescence.

Bracts

Carex chitralensis was higher number of bracts than other *Carex* species. Bract length was much higher present in *Carex chitralensis* and *Carex atrofusa*. These length measurements of *Carex* species are present in Table (3) shows all these characteristics. However *Carex flacca* and *Carex omiana* was lower length of bracts. Bract width was higher present in *Carex remota*, *Carex atrofusa*, *Carex divulsa* and *Carex nubigena* was lowest width than other species. All these Bract length and width was shown in Table (3).

Anther

Carex remota, *Carex cruciata* and *Carex atrofusa* was higher length of anther. However *Carex fedia*, *Carex flacca*, *Carex filiciana*, *Carex royleana*, *Carex karoii*, *Carex Omiana*, *Carex decaulescens* and *Carex vulpenaris* had minimum length of anther. All character of these species is present in Table (3).

Table 3: Quantitative morphological characteristics of inflorescence, bract and anthers in some species of genus *Carex* (Cyperaceae) from the Murree Hills

Species	Inflorescence			Bract		Anther length (mm)
	Diameter (mm)	Length (mm)	Branches (mm)	Length (mm)	Width (mm)	
<i>Carex fedia</i>	31.1	40.2	1.25	32.2	12.1	0.25
<i>Carex flacca</i>	14.2	59.2	1.3	21.2	4.5	1.5
<i>Carex filiciana</i>	44.3	61.2	3.2	61.2	4.5	1.2
<i>Carex remota</i>	36.3	31.5	2.3	41.2	6.8	1.8
<i>Carex royleana</i>	31.3	21.5	3.5	51.55	4.5	0.35
<i>Carex canescens</i>	21.2	61.5	2.3	71.66	3.5	1.46
<i>Carex chitralensis</i>	36.5	46.2	1.4	139.22	3.6	1.45
<i>Carex karoii</i>	54.7	21.6	3.8	51.55	5.8	0.39
<i>Carex foliosa</i>	71.55	139.22	2.9	21.55	4.5	1.11
<i>Carex cruciata</i>	36.8	175.12	3.8	31.55	5.8	1.7
<i>Carex haematostoma</i>	21.44	31.3	2.7	139.22	8.7	1.22
<i>Carex atrofusa</i>	41.12	80.5	2.4	229.11	9.5	2.3
<i>Carex decaulescens</i>	71	230	3	530	11	1.3
<i>Carex divulsa</i>	51.55	94.5	1.23	41	9	1.36
<i>Carex omiana</i>	61.2	85.4	2.3	21	4	0.22
<i>Carex plectobasis</i>	30.6	140.4	2.5	60.22	3.7	1.3
<i>Carex sanguinea</i>	30.5	150.78	1.6	51.23	5.8	1.4
<i>Carex brunnea</i>	51.24	64.5	1	200	6.78	1.9
<i>Carex cruenta</i>	71.23	55.4	2.3	250	5.6	1.5
<i>Carex nubigena</i>	61.21	33.11	2.5	139	6.5	2.5
<i>Carex lateralis</i>	41.5	48	1.33	120	6.7	1.24
<i>Carex turkestanica</i>	40.55	60.22	1.7	60.5	4.8	1.7
<i>Carex vulpenaris</i>	51.23	56.4	1.22	41.11	5	1.3
<i>Carex decaulescens</i>	71	230	3	530	11	1.3

Spikelet

Carex karoii, *Carex atrofusa* and *Carex canescence* was higher number of spikelets. Mostly species *Carex flacca*, *Carex royleana* and *Carex foliosa* was lower number of spikelet. Spikelet length was higher in *Carex chitralensis*, *Carex foliosa* and *Carex haematostoma*. Male Spikelet length was higher in *Carex cruciata*, *Carex flacca* and *Carex vulpenaris*. Female spikelet in *Carex cruciata*, *Carex chitralensis* and *Carex vulpenaris* had maximum length than other species. Commonly *Carex filiciana* and *Carex divulsa* had maximum width than other species. Female spikes were maximum width in *Carex karoii*, *Carex remota* and *Carex cruenta*. Female spikes were minimum width present in *Carex remota*, *Carex cruciata* and *Carex vulpenaris*. However *Carex flacca*, *Carex filiciana* and *Carex haematostoma* had minimum width of spikelet. All these species and their data are represented in Table (4).

Glumes

Carex chitralensis, *Carex divulsa* and *Carex fedia* had greater number of glumes. However *Carex*

flacca, *Carex vulpenaris* and *Carex canescence* had lower number of glumes. Maximum length of glumes presented in *Carex karoii*, *Carex sanguinea* and *Carex chitralensis*. *Carex brunnea*, *Carex divulsa* and *Carex cruenta* had minimum length. We investigate that *Carex brunnea*, *Carex haematostoma* and *Carex fedia* had maximum length of glumes than other species.

Commonly *Carex fedia*, *Carex chitralensis* and *Carex brunnea* had maximum length than other *Carex* species. Maximum width of glumes was present in *Carex royleana*, *Carex cruenta* and *Carex foliosa* and other species also had maximum width of glumes in *Carex fedia*, *Carex royleana* and *Carex vulpenaris*. Minimum width of glumes was present in *Carex turkestanica*, *Carex vulpinaris* and *Carex nubigena*. These all species and data are represented in Table (5). As well as female glumes was in minimum length present in *Carex brunnea*, *Caerx plectobais* and *Caex cruenta*.

Table 4: Quantitative morphological characteristics of spike in some species of genus *Carex* (Cyperaceae) from the Murree Hills

Species	Spike			Length (mm)			Width (mm)		
	Number	General	Male	Female	General	Male	Female	General	Male
<i>Carexfedia</i>	2.5	12	8	6.3	3.7	1.6	13.2	4.5	1.9
<i>Carexflacca</i>	3	15	10	4.2	15	6	12.5	4	3.7
<i>Carexfiliciana</i>	2.5	1.8	2	5.7	1.4	1.8	20.11	3	3.3
<i>Carexremota</i>	4	1.25	2.7	14.7	3	2	16.5	24.5	14
<i>Carexcroyleana</i>	3.7	2	1	15.7	1.8	1.9	13.8	15	5
<i>Carexchitralensis</i>	4.7	2.66	3	15.9	1.5	2.5	5.4	20	7
<i>Carexkaroii</i>	4.9	6	8	5.5	8	2.4	15	27	6
<i>Carexfoliosa</i>	3.7	2.7	2.2	15.4	2.4	15	4	3	4
<i>Carexcruciata</i>	4.6	5	6	15.2	20	3.5	4	4	10
<i>Carexhaematostoma</i>	5.7	0.2	3.8	20	7	25	6.5	1.5	3
<i>Carexatrofusa</i>	8.1	3	4	25	0.7	0.9	2.5	7	11
<i>Carexdecaulescens</i>	2.3	1.1	1.7	8	2.6	1.7	3.7	0.3	4
<i>Carexdivulsa</i>	11	5.4	3.3	6.8	2.5	4.6	16	5	7
<i>Carexomiana</i>	4.5	3	3.5	19	4.5	5	15.7	2	2.5
<i>Carexplectobasis</i>	7.4	2.3	3.4	21	4.7	4	3.2	5.1	2.9
<i>Carexsanguinea</i>	6.8	2	2	18.1	21	35	6.5	2.2	5.2
<i>Carexbrunnea</i>	7.4	1.25	3	5	24	11	4.7	3	4
<i>Carexcruenta</i>	5.8	1.89	2.6	31.5	13.2	2.7	7	18	3.7
<i>Carexnubigena</i>	4.8	1.75	2.5	16	14	12	6	2	3.2
<i>Carexlateralis</i>	4.77	1.66	2.9	31	20	0.34	2.8	3.4	2.8
<i>Carexturkestanika</i>	3.12	1.24	2	40.5	20	15	4.8	2.5	2.9
<i>Carexvulpinaris</i>	6.4	1.22	2	20	23.5	18	4.7	3	4
<i>Carexcanescens</i>	8.9	2.2	3	11.3	22	17.5	6	2	3.3
<i>Carexhaematostoma</i>	5.7	0.2	3.8	20	7	25	6.5	1.5	3

Table 5: Quantitative morphological characteristics of glumes in some species of genus *Carex* (Cyperaceae) from the Murree Hills

Species	Glumes								
	Bract Length (mm)	Prophyll Length (mm)	Glumes/spike (mm)	Length (mm)			Width (mm)		
				General	Male	Female	General	Male	Female
<i>Carexfedia</i>	3.5	2.4	23.7	4.25	4.5	3.7	0.27	6	4.2
<i>Carexflacca</i>	3	1.77	32.4	2.8	1.8	3.3	1.25	1	1.2
<i>Carexfiliciana</i>	2.8	1.32	24	2.25	1.6	2.9	3.12	1.8	0.43
<i>Carexremota</i>	0.65	0.45	15.7	3.7	1.5	2.5	2.8	3	2.9
<i>Carexcroyleana</i>	0.24	0.23	17	2.77	4.5	4	1.32	0.22	2.7
<i>Carexchitralensis</i>	2.56	0.36	25.4	2.88	4.23	3	1.8	0.13	3.7
<i>Carexkaroi</i>	2.76	2.55	30.2	3.5	2.3	3	0.27	0.11	3.6
<i>Carexfoliosa</i>	2.22	1.75	23.5	4.9	2.2	3.7	2.13	1.3	1.5
<i>Carexcruciata</i>	3.4	0.26	17.5	3.5	6	5.1	4	0.77	2
<i>Carexhaematostoma</i>	2.9	2.22	18.36	3.8	3.48	3.5	1.8	0.68	0.95
<i>Carexatrofusa</i>	3.6	0.43	8.67	4.2	4.5	5.1	0.33	2.5	0.46
<i>Carexdecaulescens</i>	2.89	0.97	14.11	2.7	2.6	3.5	0.55	3.1	2.5
<i>Carexdivulsa</i>	0.98	0.54	13.7	2.55	2.5	5.1	0.62	4.6	3.5
<i>Carexomiana</i>	0.85	2.44	11.6	4.9	3.5	3.5	1.2	5	4
<i>Carexplectobasis</i>	2.4	1.3	12.5	3.4	4.5	5.1	0.45	0.34	0.29
<i>Carexsanguinea</i>	2.64	1.2	14.5	3.22	5.7	2.4	2.11	0.76	0.23
<i>Carexbrunnea</i>	0.40	2.55	14.25	2.5	4	3	2.2	0.89	1.5
<i>Carexcruenta</i>	0.95	2.5	21.5	2.8	4.5	4.5	1.7	0.29	1.4
<i>Carexnubigena</i>	2.23	0.75	23	2.61	5.4	3.2	1.62	0.33	0.22
<i>Carexlatialis</i>	3.8	1.11	14	3.1	3.8	2.22	0.61	0.89	2.7
<i>Carexturkestanika</i>	2.14	2.8	17	4	3.7	4	3.7	0.99	0.82
<i>Carexvulpinaris</i>	2.4	0.44	15	0.55	5.7	4.2	1.7	2.55	2.3
<i>Carexcanescens</i>	2.2	1.5	14	0.55	3.28	3.2	0.29	0.23	0.42

Qualitative morphological characteristics***Carexfedia***

Terminal spike in the inflorescence of *Carexfedia* was male, whereas lower was the female spikes. The spike of *C.fedia* was cylindrical and dark brown in color. Male glumes of *C. fedia* were lanceolate and dark brown in color. Female glumes were ovate, acute or acuminate and dark brown in color. The surface of glumes is generally slightly hairy and apex was papillose. All these character are shown in Table (6).

Carexflacca

In the inflorescence of *Carexflacca* male spikes were on the terminal and lower were the female spikes. The shape of spikes was globular-elliptic and color was green brown. The glumes shape of *C. flacca* was mucronate, surface was slightly hairy and color was yellowish green. The apex of glumes was scariosus. All these characters are represented in Table (6) and (7).

Carexfiliciana

Terminal male and lower female spikes in the inflorescence of *Carexfiliciana*. The spike shape of *C. filiciana* was cylindrical and spike color was pale brown. The female glumes shape was obovate-oblong or oblong and color was pale to reddish brown. The

glumes were scariosus pubescent and apex was truncate. All these character was showed in Table 6 to 7.

Carexremota

Terminal was gynecandrous male and lower nodding or drooping were female spikes in the inflorescence of *Carexremota*. The male spike shape of *C. remota* was fusiform to slightly clavate and color was black brown-brown. Its female spike shape was cylindrical or ellipsoid and color was black. The male glumes shape of *C. remota* was ovate to obovate-acute and glumes color was brown. Its female glumes shape was ovate or elliptic-acute and glumes color was black-brown. The glumes were scariosus pubescent and its apex was scabrous. All these characters are represented in Table 6 to 7.

Carexcroyleana

Terminal was male spike and lower overlapped female spike of the *Carexcroyleana*. The spike shape of this specie was fusiform or club-shaped and spike color was dark grey-brown. The male glumes shape of *C. royleana* was acute and the female glume shape was truncate but the glumes color was green. The glumes were scariosus pubescent and apex is truncate. Species represented in Table 6 to 7.

Carexkaroi

Terminal was male spike and lower was female spike of *Carexkaroi*. The spike shape of this specie was obovoid and spike color was green-brown. The glumes shape was oblong-lanceolate and glumes color was yellowish-green. The glumes were scariosly pubescent and apex was scarios. All these characters of *Carexkaroi* species represented in Table 6 to 7.

Carexchitralensis

The inflorescence of *Carexchitralensis* was androgynous spike. The male spike shape was cylindrical and ellipsoid whereas female spike shape was globular-cylindrical in the *C. chitralensis*. The spike color was generally green to reddish brown in it. The glume shape of *C. chitralensis* was ovate and acute while its color was brown-reddish brown. The glumes was scariosly pubescent and apex was scabrous in *C. chitralensis*. All these species described in Table 6 to 7.

Carexfoliola

Terminal was male spike and lower was female spike of *Carexfoliola*. The male spike of this specie was fusiform, sessile and overlapping and female spike was cylindrical or ellipsoid. The male glumes shape of *C. foliosa* was lanceolate to oblanceolate and female glumes shape was lanceolate and acute. The female glume color was dark brown. The glumes were scariosly pubescent and apex was scarios.

Carexcruciata

The inflorescence type of *Carexcruciata* was an androgynous, sessile or lowest pedunculate. The spike shape of this specie was globular or somewhat elongate. The glumes shape was triangular to ovate and acute or acuminate. All these species are shown in Table 6 to 7.

Carexhaematostoma

The inflorescence type of *Carexhaematostoma* was an androgynous spike. The spike shape of *C. haematostoma* was cylindrical and spike color was dark brown. The glumes shape of *C. haematostoma* was obovate and obtuse and the glumes color were brown to dark brown. The glumes of this specie were scariosly pubescent and the apex was scabrous. All species of *Carex haematostoma* was presented in Table 6.1 to 7.1.

Carexatrofusa

Terminal was male spike and lower was female spike but occasionally androgynous spikes were present in *Carexatrofusa*. The spike shape in this specie was cylindrical but spike color was light brown. The male glumes shape was narrowly ovate and acute and glumes color was light brown. The female glumes shape was ovate and obtuse to acute and glumes color was brown. Glumes were scariosly pubescent and apex was scarios. These species of *Carexatrofusa* was represented in Table 6 to 7.

Carexdecaulescence

Terminal was male spike and lower was female spike of *Carexdecaulescence*. The spike shape of this specie was obovoid and spike color was green-brown. The glumes shape was oblong-lanceolate and glumes color was yellowish-green. The glumes were scariosly pubescent and apex was scarios. All these characters are represented in Table 6 to 7.

Carexdivulsa

The inflorescence type of *Carexdivulsa* was an androgynous spike. The spike shape of *C. oligocarya* was cylindrical or fusiform and color was brown. The male glumes shape of this specie was narrowly elliptic and female glumes shape was acute, margins widely scarios. The glumes color was yellowish brown, glume was scariosly pubescent and apex was scarios. All these species of *Carexdivulsa* are represented in Table 6 to 7.

Carexomiana

The inflorescence type of *Carexomiana* was an androgynous, sessile or lowest pedunculate. The spike shape of this specie was globular or somewhat elongate. The glumes shape was triangular to ovate and acute or acuminate. These characters are represented in Table 6 to 7.

Carexplectobasis

The inflorescence type of *Carexplectobasis* was staminate spikes occasionally androgynous. The male spike shape was fusiform to clavate and female spike shape was erect. The male spike color was yellowish-brown. The male glume shape was ovate or obovate and acute but female glumes shape was acuminate. The color of male glumes were yellow-brown and female glumes was brown. The glumes were scariosly pubescent. All these species were represented in Table 6 to 7.

Carexsanguinea

The inflorescence type of *Carexsanguinea* was androgynous spike. The spike shape of this specie was cylindrical and spike color is brown. The male glumes shape of *C. sanguinea* was cymbiform, obtuse or acute and mucronulate and female glume shape was cymbiform. The glumes color was light brown, scariosly pubescent and apex was scarios. All these characters were represented in Table 6 to 7.

Carexbrunnea

The inflorescence of *Carexbrunnea* was androgynous, male part much shorter than female part. The spike shape of *C. brunnea* was cylindrical and spike color was brownish green. The glumes shape of *C. brunnea* was generally obtuse to acute but female glumes were ovate and glume color was generally pale to reddish brown but female glume was yellowish brown in color. The glumes were scariosly pubescent and glume apex was acute or obtuse. Species of *Carexbrunnea* showed in Table 6 and 7.

Carexcruenta-

Terminal was gynecandrous male and lower nodding or drooping were female spikes in the inflorescence of *Carexcruenta*. The male spike shape of *C. cruenta* was fusiform to slightly clavate and color was black brown-brown. Its female spike shape was cylindrical or ellipsoid and color was black. The male glume shape of *C. cruenta* was ovate to obovate-acute and glume colour was brown. Its female glume shape was ovate or elliptic-acute and glume color was black-brown. The glume is scariosly pubescent and its apex was scabrous. Table 6 to 7 has all these characters.

Carexnubigena

The inflorescence type of *Carexnubigena* was an androgynous spike. The spike shape of *C. nubigena* was cylindrical and color was light brown. Generally the glume shape was obolong-lanceolate but male spike shape was triangular and generally glume color was yellowish green. The glume was scariosly pubescent and apex was artistate. All these species are represented in Table 6 to 7.

Carexlateralis

Terminal was male spike and lower was female spike of *Carexlateralis*. Generally spike shape of *C. lateralis* was cylindrical and the male spike shape was

fusiform or clube-shaped. Generally spike shape of this specie was dark brown and female spike color was green. The glume shape of *C. lateralis* was obovate and color was yellowish brown. The glume was scariosly pubescent and apex was scarios. All these characters are represented in Table 6 to 7.

Carex turkestanica

The inflorescence type of *Carexturkestanica* was gynecandrous. The male spike shape of this specie was fusiform or club-shaped and female spike shape was ellipsoid and cylindrical or globose. The spike color was brown. The male glume shape was ovate or elliptic and obtuse or acute and female glume shape was ovate and acute. The glume was scariosly pubescent, glume color was reddish brown and apex was truncate. Table 6 to 7 has these species of *Carex Turkestanica*.

Carex vulpinaris

The inflorescence type of *Carexvulpinaris* was tightly group of androgynous spike. The spike shape of this specie was elongated or globular and spike color was greyish brown. The female glume shape was deltate, cymbiform and acute. The glume colour was greenish or yellowish brown. Glume was scariosly pubescent and apex was scarios. All these species of *Carex vulpenaris* are represented in Table 6 to 7.

Table 6.1: Qualitative morphological Characteristics of Flower structure and spikelet in few species of genus Carex (Cyperaceae) from Murree Hill-

Specie	Flower (Inflorescence) Type	Spikelet shape			Spikelet color		
		General shape	Male part	Female part	General shape	Male part	Female Part
<i>Carexfedia</i>	Terminal male, globular female spikelet	Cylindrical	cylindrical	cylindrical	Pale yellow	Light brown	Greenish
<i>Careflacca</i>	Terminal male, lower female spikelet	Globular	Cylindrical	cylindrical	Brown	Dark brown	Light brown
<i>Carexfiliciana</i>	Androgynous, male part much shorter than female part	Cylindrical	Cylindrical	Cylindrical	Greenish	Brownish	Light brown
<i>Carexremota</i>	Terminal male, lower female spikes	Cylindrical	Globular	Cylindrical	Pale brown	Dark brown	Light brown
<i>Carexroyleana</i>	Androgynous spike	Globular	Cylindrical, ellipsoid	Globular-cylindrical	Green to reddish brown	Light brown	Green
<i>Carexkaroi</i>	Apical spike, lower nodding female spikes	Cylindrical	Globular	Cylindrical	Light brown	Black brown	Black
<i>Carexchitralensis</i>	Over topping	Cylindrical	Globular	Cylindrical	Reddish brown	green	Reddish brown
<i>Carexfoliosa</i>	Androgynous inflorescence	Androgynous	Lowest spike	Triangular	Dark brown	Dark brown	green

<i>Carexcruciata</i>	Ovoid pyramidal	Cylindrical	Ovate	ellipsoid	Dark brownish	Brown	Green
<i>Carexhaematostoma</i>	Androgynous	Cylindrical	Androgynous	ellipsoid	Yellowish	Dark brownish	Brown
<i>Carexatrofusa</i>	Gynecandrous	Ovoid	ellipsoid	ellipsoid	Brown	Light brown	Dark brown
<i>Carexdecaulescens</i>	Terminal Gynandrous	Club shape	Ovate	Cylindrical	Green	Brown	Reddish brown
<i>Carexdivulsa</i>	Androgynous spike	Globular	Cylindrical	globular	Green	Light brown	Green
<i>Carexomiana</i>	Globose	Gynaecandrous	Terminal	Ovate	Yellowish	Green	Brown
<i>Carexpectobasis</i>	Androgynous	Globular	Cylindrical	Ovate	Greenish	Light brown	Dark brown
<i>Carexsanguinea</i>	Overlapping	Cylindrical	Ovate	Globular	Light brown	Greenish	Yellowish
<i>Carexbrunnea</i>	Ellipsoid	Globular	Cylindrical	Ovate	Yellowish	Reddish	Green
<i>Carexcruenta</i>	Apical	Erect	Globular	Cylindrical	Green	Yellow	Brown
<i>Carexnubigena</i>	Overtopping	Androgynous	Globose	Triangular	Grey-green	Light brown	Green
<i>Carexlatialis</i>	Androgynous	Erect	Globular	Cylindrical	Dark brown	Greenish	Yellow
<i>Carexturkestanica</i>	Terminal	Cylindrical	Globular	Ovate	Green	Yellow	Reddish
<i>Carexvulpinaris</i>	Androgynous	Erect	Ovate	Globular	Brown	Grayish	Yellow

Table 7.1: Qualitative morphological characteristics of Glumes in *Carex* (Cyperaceae) from Murree Hills

Species of <i>Carex</i>	Glumes shape			Glumes pubescence	Glumes color			Glumes apex
	General	Male part	Female part		General	Male part	Female part	
<i>Carexfedia</i>	Triangular	Obovate	Acute	Spongy	Green	Brown	Light brown	Scarious
<i>Carexflacca</i>	Obovate	Acute	Obtuse	aristate	Brown	Green	Greyish	Papillose
<i>Carexfiliciana</i>	Long-acuminate	Acute	Hispid	Arista	Green	Red	Light brown	Ciliate
<i>Carexremota</i>	Erect	Obovate	Obtuse	Aristate	Yellow	Green	Dark brown	Papillose
<i>Carexcryoleana</i>	Triangular shape	Ovate	Ovate	Arista	Dark brown	Grey	Green	Ciliate
<i>Carexchitralensis</i>	Ovate	Acute	Ovate	Scarious	Reddish brown	yellow	Green	Papillose
<i>Carexkaroi</i>	Ovoid	Rounded	Caducous	Ciliate	Dark brown	Brown	Light brown	Scarious
<i>Carexfoliosa</i>	Triangular	Globose	Ovate	Arista	Green	Yellow	Brown	Scarious
<i>Carexcruciata</i>	Murconate	Ovate	Ovoid	scabrous	Brown	Green	Yellow	scarious
<i>Carexhaemastoma</i>	Obovate	Obovate	Obotuse	Widely Scarious	Yellow	Red	Brown	Barbed
<i>Carexatrofusa</i>	Obtuse	Ovoid	Obtuse	Arista	Blackish brown	Brown	Light brown	Papillose
<i>Carexdecaulescens</i>	Ovate	Obtuse	Acute	Arista	Reddish	Brown	Green	Papillose
<i>Carexdivulsa</i>	Ovate	Obtuse	Acute	Scarious	Green	Red	Brown	Ciliate
<i>Carexomiana</i>	Broadly ovate	Ovoid	Ovate	Arista	Red	Yellow	Green	Spongy

<i>Carexplectobasis</i>	Ovate	Globular	Ovoid	Arista	Grey	Green	Red	Ciliate
<i>Carexsanguinea</i>	Triangular	Elipsoid	Ovate	Spongy	Red	Grey	Brown	Papillose
<i>Carexbrunnea</i>	Ovate	Ovoid	Round	Arista	Grey	Brown	Red	Cilliate
<i>Carexcruenta</i>	Triangular	Ovate	Ovoid	Spongy	Green	Red	Grey	Papillose
<i>Carex nubigena</i>	Ovate	Ovoid	Triangular	Spongy	Yellow	Grey	Red	Cilliate
<i>Carex lateralis</i>	Ovate	Globose	Erect	Arista	Red	Grey	Brown	Spongy
<i>Carexschlagintweitiana</i>	Ovoid	Elipsoid	Triangular	Arista	Yellow	Grey	Red	Paillose
<i>Carexturkestanica</i>	Triangular	Ovate	Ovoid	Spongy	Green	Red	Yellow	Cilliate
<i>Carexvulpinaris</i>	Triangular	Ovoid	Ovate	Spongy	Green	Red	Yellow	Cilliate

Dissusion

Three floras have been written on family Cyperaceae until now and two of them become out dated and less important. The first research work was published on grasses and sedges of Lahore district by Ahmad (2000). There are abundance form of species was investigated of Cyperaceae family. But few grasses have not clear evidence about their characters. Most recent and perfect worked done by Kukkonen (2001). However recent herbaria contain 42 grasses of this Cyperaceae family was published in University of Punjab. Murree Hills have almost 500 species and 10 genera such as *Baumea* (3 species), *Caustis* (3 species), *Carex* (3 species), *Cladium* (10 species), *Eleocharis* (7 species), *Kobresia* (4 species), *Cyperus* (3 species), *Machaerina* (2 species), *Lepironia* (5 species) and *Kylinga* (6 species). Ranganth (2002) investigated 23 genus and almost 180 species. All these species were collected from Murree Hills, Bansra Galli and Jhinka Galli. The herberium sheet has these species such as *Websteria* (9 species), *Uncinia* (8 species), *Trichophorum* (7 species), *Scleria* (6 species), *Scirpus* (5 species), *Scirpoides* (4 species), *Scirpodendron* (3 species), *Schoenus* (2 species), *Remirea* (11 species), *Pycneus* (12 species), *Oreobolus* (10 species), *Lepironia* (1 specie). Commonly grasses of this Cyperaceae family are not similar to each other. All these species was different due to micro-morphological characteristics. However all these species were originate from subgenus and formed one of the largest genus (Simposen, 2001). Mostly Cyperaceae family related with Poaceae family or Liliaceae family. Mostly all the species have three genera which are similar due to morphological characters. These species have ability to bear environmental (Rodrigues, 2002).

One of the largest genera known as *Carex* has similar characters with the Cyperacea and Liliaceae families. Cyperaceae family has 90 genus and 5,500 species in all flora of Pakistan (Kukkonen, 2001). The largest genus *Carex* related with other 2000 which have 109 genera and 2000 (Govaerts 2012). Commonly all species of this genera are distributed in all over the world such as flora of Pakistan and flora of China. All the climatic changing and nutrient rich

areas have these species in South Africa and United state of America (Bruhl, 2007).

In flora of Pakistan 75 species of this Cyperaceae family was presented in temperate regions such as Murree Hills, Bansra Galli and Jhinka Galli (Larridon, 2010). However 25 species of this Cyperaceae were recorded in high altitude of Pakistan. By the different studies we investigated that there is no recent species of Cyperaceae was recorded. But the photography and inflorescence study was recorded in a few last years in flora of Pakistan. Mostly species of this Cyperaceae family distributed was in marshy, moisturized and nutrient rich soil. But commonly these species grow in temperate environment and water absorbing soil where they bear all the environmental factors such as light and heat etc. Mostly their growing lands are high altitude, latitude, mountains, sub-temperate forest and moisturize places. Mostly grasses present on upper land such as Murree Hills, Bansra Galli and Jhinka Galli. Salty areas also had these monocotyledon grasses.

All the data of Cyperaceae family together from the temperate regions of Pakistan and salty areas such as (Johrabad, Khushab, Bhakkar, Jhang and Jehlum) and latitude areas of Punjab have also these grasses in Bansra Galli, Jhinka Galli and Nathia Galli. Few species of Cyperaceae family can bear heat which is present in tropical areas or grow in salty areas (Reinheimer, 2007). Mostly species can bear environmental factors and these grasses grow in marshy areas, bank of rivers, canals, ponds and all open plains. These grasses give nutrients to small insect, flying birds, water birds and also best source of fire fumes. Commonly shady areas and sub-temperate forest and moisturized places have all these monocotyledon species (Richard 2002). The grasses of genera *Carex* grow from high altitudes and lower latitude. We collect flora of Pakistan from Murree Hills, Bansra Galli and Jhinka Galli. *Carex karoii*, *Carex divulsa*, *Carex diandra*, *Carex chitralensis*, *Carexroyleana* and *Carex remota* are collected from Murree Hills. Jhinka Galli and Bansra Galli also had this monocotyledon species. Mostly irrelevant characters of flower are beneficial for further investigation of these monocotyledon species at the

base of taxa and sections (Stevens, 2012). Generally qualitative characters glumes structure, bud structure, width and diameter was presented in this genera *Carex* (Simposn et al., 2003). By the taxonomic glumes and flower structure of genera *Carex* had very important information. All the species are dioecious and monoecious. All the species was distributed in all over the world. Mostly monoecious species are present in flora of Pakistan (Rodrigues, 2002). The female bracts have a small vassal part and different glumes structure (Ball Reznicek, 2002).

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2/25/2021