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Chromosomal Analysis of *Fimbristylis* Vahl in Punjab, North West India

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Chromosomal analysis of populations of nine species of sedges namely, *F. bisumbellata* (10 populations) n = 5 = 2x, *F. dichotoma* (5 populations) n = 5 = 2x and n = 10 = 4x, *F. falcata* n = 11 = 2x, *F. ferruginea* (3 populations) n = 10 = 4x, *F. miliacea* (3 populations) n = 5 = 2x, *F. monostachya* n = 5 = 2x, *F. polytrichoides* n = 5 = 2x, *F. quinquangularis* (5 populations) n = 5 = 2x and *F. tenera* n = 20 = 8x has been made. Chromosomes recorded are quite different from previous reports and have revealed the existence of 'biological' species within the circumvention of accepted species. Interestingly, there is lack of aneuploid numbers in *Fimbristylis* as compared to *Cyperus*, *Scirpus* and *Carex* which is possibly due to the presence of localized centromere on the chromosomes making nonviable chromosome fragments.

Key Words: ***Fimbristylis*, "Biological" species, Polyploid, Aneuploid, Localized centromere**

Introduction

Amongst the sedges, members of *Fimbristylis* Vahl are well distributed throughout the world with about 300 species (Willis 1966). Out of these 50 species are recorded from India (Santapau & Henry 1973). On world-wide basis, significant cytological information about the genus has been provided by Tanaka (1937, 1939), Dnyansagar and Tiwari (1956), Sharma and Bal (1956), Sharma (1962), Chuang et al. (1963), Gadella and Kliphuis (1964), Baquar (1969), Murin and Chaudhuri (1970), Sanyal and Sharma (1972) and Nijalingappa (1973, 1975, 1977). From North-western Himalayas sedges have been cytologically investigated by Mehra and Sachdeva (1971, 1975, 1976). Except for studies of Bir et al. (1986, 1988, 1990) not much work has been done on the sedges of Indo-Gangetic plains, a significant phytogeographical region of the Indian subcontinent (cf. Chatterjee 1939, 1962). Our present studies on sedges form a part of an overall project of chromosomal analysis of flora of north Indian plains with particular reference to Punjab state. Here the results of chromosomal studies of nine species of *Fimbristylis* are reported and a detailed information on the distribution of various cytotypes in the Indian state of Punjab, is given.

Materials and Methods

Materials used in the present investigation were collected from wild plants from widely different localities (table 1) in order to find out the genetic variability in different populations. Usual acetocarmine squashes of young floral buds were made after fixation for 10-12 hrs in Carnoy's fluid and desirable slides were made permanent in euparal. Voucher specimens are preserved in PUN.

Observations

Except of *F. dichotoma* different materials on chromosomal analysis were found to be of uniform type. Meiosis in all the investigated taxa is

Table 1 *Chromosome Analysis of Fimbristylis from Punjab State*

S. NO.	Taxa	Locality and altitude	Chromosome number and Figure number	Ploidy level	PUN* Accession Number
FIMBRISTYLIS VAHL					
	$x = 5,11$				
1.	*F. bisumbellata* (Forsk.) Bub.				
	Population i	Sangrur: Mastuana, 230m	n = 5 (Figs. 1,7)	Diploid	34989
	Population ii	Patiala: Nadampur, 250m	n = 5	-do-	34987
	Population iii	Patiala: Boharpur, 250m	n = 5	-do-	34986
	Population iv	Sangrur: Mastuana, 230m	n = 5	-do-	35233
	Population v	Sangrur: Bahadurpur, 230m	n = 5	-do-	35235
	Population vi	Faridkot: Chail, 205m	n = 5	-do-	35236
	Population vii	Ferozpur: Head Works, 260m	n = 5	-do-	35238
	Population viii	Bhatinda: Thermal plant, 250m	n = 5	-do-	35239
	Population ix	Bhatinda: Sivian, 250m	n = 5	-do-	35240
	Population x	Jalandhar: Beas, 260m	n = 5	-do-	35241
2.	*F. dichotoma* ((L.) Vahl				
	Population i	Ropar: Nangal, 600m	n = 5 (Fig. 8)	-do-	35261
	Population ii	Bhatinda: Thermal plant 250m	n = 10 (Figs 2,9)	Tetraploid	35242
	Population iii	Patiala: University Campus, 251m	n = 10	-do-	35243
	Population iv	Patiala: Zirakpur, 250m	n = 10	Tetraploid	35244
	Population v	Patiala: Zirakpur, 250m	n = 10	-do-	35245
3.	*F. falcata* (*Vahl*) *Kunth* (= *F junciformis* Kunth)	Jalandhar: Beas, 260m	n = 11 (Fig. 10)	Diploid	35402
4.	*F. ferruginea* Vahl				
	Population i	Patiala: University Campus, 251m	n = 10	Tetraploid	34984
	Population ii	Sangrur: Mastuana 250m	n = 10	-do-	34985
	Population iii	Ropar: Headworks, 400m	n = 10 (Figs 3, 11)	-do-	34983
5.	*F. miliacea* Vahl				
	Population i	Patiala: Boharpur, 250m	n = 5	Diploid	34981
	Population ii	Patiala: Boharpur, 250m	n = 5 (Figs 4, 12)	-do-	35246
	Population iii	Patiala: Boharpur, 250m	n = 5	-do-	35247
6.	*F. monostachya* (L.) Hassk. (= *F. ovata* (Burm. f) Kern)	Ropar: Nangal, 600m	n = 5 (Fig. 13)	-do-	35403
7.	*F. polytrichoides* R.Br.	Patiala: Zirakpur, 250m	n = 5 (Figs 5, 14)	-do-	35262
8.	*F. quinquangularis* (Vahl) Kunth				
	Population i	Patiala: University Campus, 250m	n = 5	Diploid	34976
	Population ii	Ropar: Headworks, 400m	n = 5 (Figs 6, 15)	-do-	34976
	Population iii	Sangrur: Bahadurpur, 230m	n = 5	-do-	34980
	Population iv	Patiala: Rajpura, 251m	n = 5	-do-	34978
	Population v	Sangrur: Mastuana, 230m	n = 5	-do-	35248
9.	*F. tenera* Roem & Schult.	Jalandhar: Beas, 260m	n = 20 (Fig. 16)	Octaploid	35404

*Abbreviation in conformity with Index Herbariorum.

uniformally normal resulting in regular sized apparently viable pollen. The results are presented in table 1. Pollen fertility is 90% as judged after staining pollen with glycero-acetocarmine by following Mark's (1954) method. Only in case of population iv of *F. bisumbellata* collected from near Sangrur the pollen fertility is lower (66%). On the basis of cumulative chromosomal data from the state, the distribution of various cytotypes of so far analysed species is shown in figure 17.

A perusal of data in table 1 indicates that with the exception of *F. dichotoma*, the other eight species and their populations exhibit a great amount of uniformity in chromosome numbers. In *F. dichotoma*, both diploid (figure 8) and tetraploid (figures 2, 9) cytotypes are recorded. These are morphologically distinct as earlier noted by us (Bir et al. 1988). Tetraploid plants are more widely distributed because out of five populations analysed four were found out to be tetraploid. These are robust in appearance, have thicker stem, long leaves, long spikelets, wide epidermal cells and narrow stomata as compared to diploid individuals.

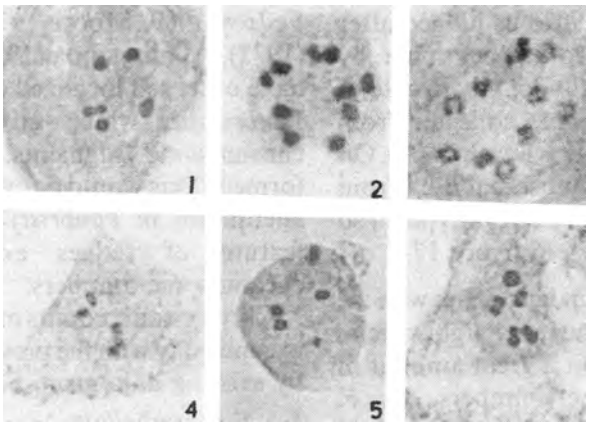
Discussion

Darlington and Wylie (1955) have suggested four base numbers x = 5, 6, 8, 11 for the genus. All the species studied by us except *F. falcata* (n = 11), are based on x = 5; *F. bisumbellata, F. milliacea, F. monostachya, F. polytrichoides* and *F. quinquangularis* are diploid whereas *F. ferruginea* and *F. tenera* are tetraploid and octaploid respectively. *F. dichotoma* is represented by both diploid and tetraploid cytotypes. So far *F. falcata* (n = 11) is taken as a diploid species based on x = 11. However, we feel that it is an aneuploid at tetraploid level as based on primary base number x = 5. Even if 11 is to be regarded as one of the base numbers for *Fimbrislylis*, this number is definitely a secondarily evolved number from 5 and 6 and is of polyploid origin.

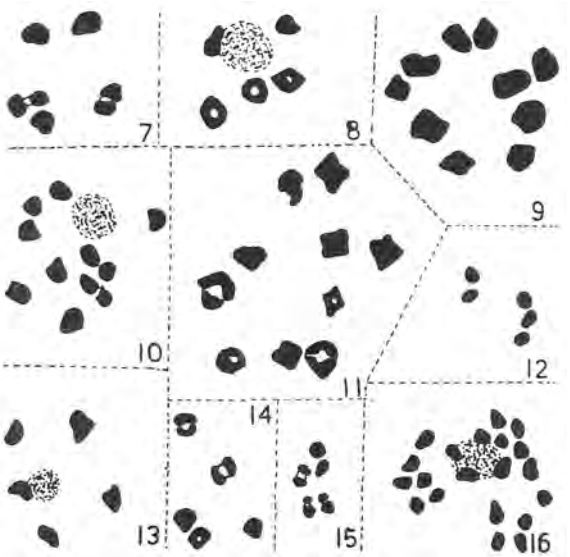
There is a complete lack of aneuploid numbers in *Fimbristylis* although high incidence of such numbers has been shown in *Cyperus, Scirpus* and *Carex* (Bir et al. 1988, 1990). Even earlier chromosomal data confirm this observation (cf. Fedrov 1969, Moore 1973). Sanyal and Sharma (1972), Nijalingappa (1975) and Bir et al. (1986) have observed localized centromere in species of *Fimbristylis* which gives rise to non-viable chromosome fragments, if these happen to be formed. This would naturally result in absence of aneuploids in *Fimbristylis* which is a common feature of sedges exhibiting the varying chromosome numbers.

Chromosome counts made by us are mostly not in confirmity with the previous records as indicated by existing data given below:

1. *F. disumbellata*: 2n = 20, recorded by Tanaka (1939), Mehra and Sachdeva (1971), Nijalingappa (1972) and Sanyal and Sharma (1972) against n = 5, 2x in all the ten populations examined by us.
2. *F. dichotoma:* varying numbers are on record as n = 15 (Kral 1971), 2n = 12 (Hus 1967-72) as against n = 5, 2x (one population) and n = 10, 4x (4 populations) reported by us. Showed (1962) recorded only n = 5, 2n = 10.
3. *F. falcata*: n = 11, 2x has been recorded by us against 2n = 44 by Nijalingappa (1975).
4. *F. ferruginea:* We found only 4x plants with n = 10 but Sharma and Sarkar (1967-68), Nijalingappa (1972) Sanyal and Sharma (1972) Mehra and Sachdeva (1975) reported n = 5, 2x for the species.
5. *F. monostachya:* Sharma and Bal (1956), Sanyal and Sharma (1972) Nijalingappa (1972) recorded 2n = 20, 4x and we found the plants with n = 5, 2x only.
6. *F. polytrichoides:* n = 5, 2x plants are located against 2n = 20, 4x reported by Sanyal and Sharma (1972).
7. *F. tenera:* Earlier 2n = 20, 4x plants are reported (Mehra & Schdeva 1975, Nijalingappa 1975, Rath & Patnaik 1978) but we found octaploid plants with n = 20.
8. *F. quinquangularis:* 2n = 20, 4x plants are recorded by Sanyal and Sharma (1972) and we found n = 5, 2x plants only.



Figures 1-6 Photomicrographs showing meiotic chromosomes. **1**, *F. bisumbellata* n = 5; **2**, *F. dichotoma* n = 10; **3**, *F. ferruginea* n = 10; **4**, *F. miliacea* n = 5; **5**, *F. polytrichoides* n = 5; **6**, *F. quinquangularis* n = 5



Figures 7-16 Meiosis in *Fimbristylis* Vahl; **7**, *F. bisumbellata* n = 5; **8**, *F. dichotoma* n = 5; **9**, *dichotoma* n = 10; **10**, *F. falcata* n = 11; **11**, *F. ferruginea* n = 10; **12**, *F. miliacea* n = 5; **13**, *F. monostachya* n = 5; **14**, *F. polytrichoides* n = 5; **15**, *F. quinquangularis* n = 5; **16**, *F. tenera* n = 20

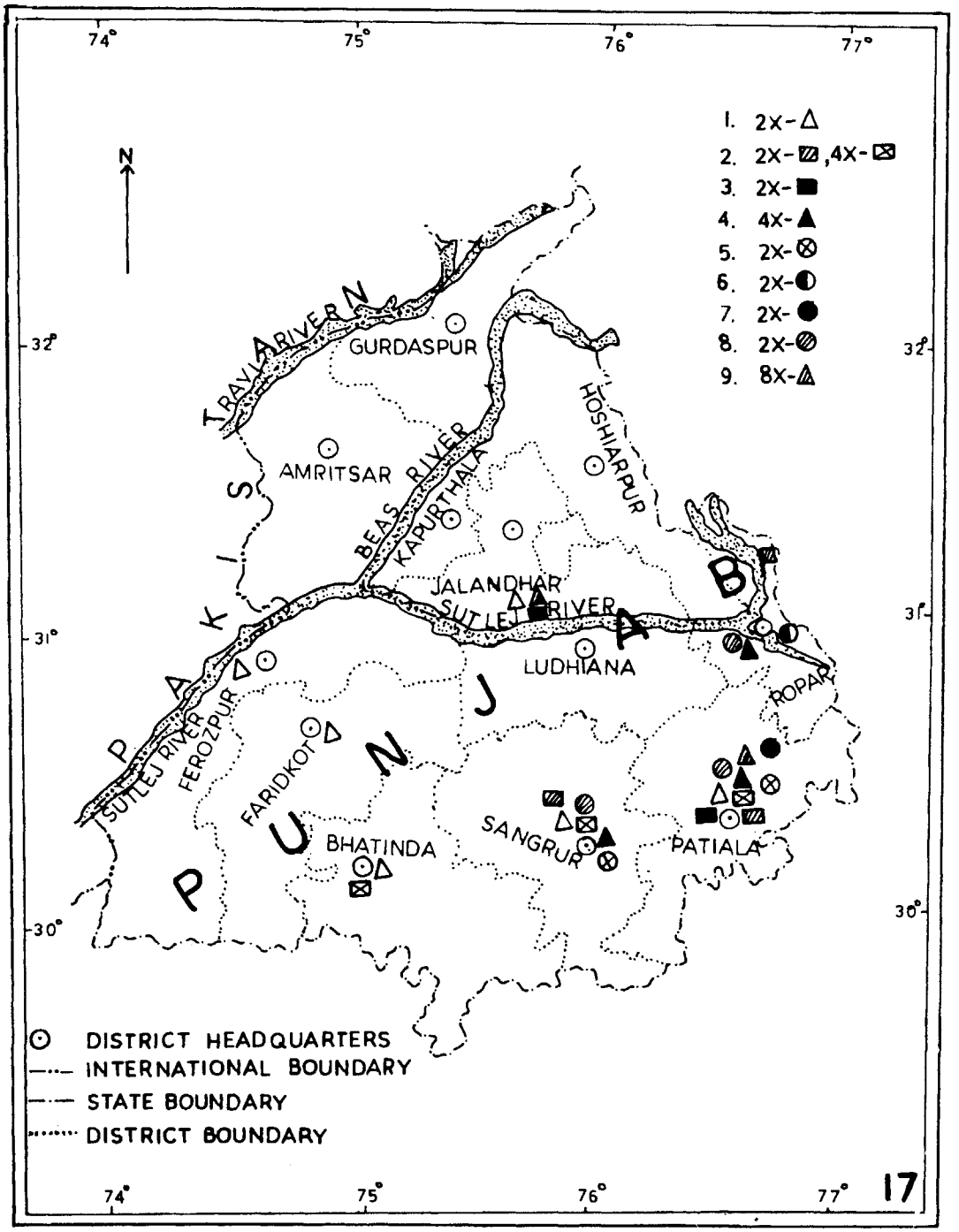


Figure 17 Map showing distribution of nine species of *Fimbristylis* in Punjab Plain. 1, *F. bisumbellata;* 2, *F. dichotoma;* 3, *F. falcata* 4, *F. ferruginea;* 5, *F. miliacea;* 6, *F. monostachya;* 7, *F. polytrichoides;* 8, *F. quinquangularis;* 9, *F. tenera*

This shows that there is a wide presence of infraspecific polyploid cytotypes or biotypes in all the species examined by us. The diploid and tetraploid cytotypes of *F. dichotoma* are easily distinguished by morphological characters as recorded by Bir et al. (1988). This indicates the genetic isolation leading to an establishment of 'biological' species (Löve 1951, 1965).

There have been a number of instances of cytotypes which are given in status of 'species', 'sub-species' or 'varieties' in spite of their being morphologically undifferentiated (cf. Ehrendrorofer 1968). But we notice differentation of dipolid and tetraploid cytotypes of *Fimbristylis dichotoma*. This makes a definite case for their taxonomic segregation at varietal level. However such a segregation is kept pending till the availability of type material of *F. dichotoma*.

Here, it may be of significance to point out the usefulness of population studies because these help in recording of the existence of 'biological' species, so common in sedges. The different biotypes in sedges are conserved through vegetative propagation.

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References

Baquar S R 1969 IOPB chromosome number reports XXIV *Taxon* **18** 683

Bir S S, Sidhu M and Kamra S 1986 Karyotypic studies on certain members of Cyperaceae from Punjab North West India; *Cytologia* **51** 95-106

———, Sidhu M, Kamra S and Cheema P 1988 Cytomorphological studies on some members of Cyperaceae from North India; *J. Cytol & Genet* **23** 14-37

———, Cheema P and Sidhu M 1990 Chromosomal variations in *Scirpus tuberosus* Desf.; *The Nucleus* **33** 22-44

Chatterjee D 1939 Studies on the endemic flora of India and Burma; *J Roy Asiatic Soc Bengal* **5** 19-67

——— 1962 Floristic pattern of Indian vegetation; *Proc. Summer School Botany*, Darjeeling pp 32-42 (New Delhi: CSIR)

Chuang T I, Chao Cy Hu WWL and Kwan S C 1963 Chromosome numbers of the Vascular plants of Taiwan I; *Taiwandia* **1** 51-56

Darlington C D and Wylie A P 1955 *Chromosome Atlas of Flowering Plants* (London: George Allen & Unwin Ltd)

Dnyansagar V R and Tiwari D K 1956 Sporogenesis and gametophytes of *Fimbristylis quinquangularis* kunth; *Bull Bot. Soc. Univ. Saugar* **8** 3-6

Ehrendorfer F 1968 Geographical and ecological aspects of infraspecific differentiation; in *Modern Methods of Plant Taxonomy* ed V H Heywood pp 261-296 (London: Academic Press)

Fedrov A A (Ed) 1969 *Chromosome Numbers of Flowering Plants* (Moscow: Academy of Sciences of the USSR)

Gadella T W J and Kliphuis E 1964 Chromosome numbers of some flowering plants collected in Surianam; *Act Bot Neerl* **13** 432-433

Hsu C C 1967-72 Preliminary chromosome studies on vascular plants of Taiwan (I); *Taiwania* **13** 117-130

Kral R 1971 A treatment of *Abilgardia bulbostylis* and *Fimbristylis* for North America; *Sida* **4** 57-227

Löve A 1951 Taxonomic evalution of polyploides; *Caryologia* **3** 263-284

——— 1965 The evolutionary framework of the biological species concept: in *Genetics Today* ed. S J Geerts **2** 409-415 (London: Pergamon)

Mark G E 1954 An acetocarmine glycerol jelly for use in pollen fertility counts; *St Technology* **29** 277

Mehra P N and Sachdeva S K 1971 IOPB chromosome number reports XXXIII; *Taxon* **20** 612

——— 1975 Cytology of some W. himalayan cyperaceae; *Cytologia* **40** 497-515

——— 1976 Cytology of some sedges of N.W. India Cytologia **41** 585-590

Moore R J (Ed) 1973 *Index to Plant Chromosome Numbers* 1967-1971 Published by Oosthoek's Uitgeversmaatschappij B.V. Domstraat 5-13 Utrecht Netherland

Murin A and Chaudhuri I I 1970 IOPB Chromosome Number Reports XXVI; *Taxon* **19** 266

Nijalingappa B H M 1972 IOPB Chromosome Number Reports XXXVIII; *Taxon* **21** 683

——— 1973 Cytological studies in *Fimbristylis dichotoma* (L.) Vahl; *Curr. Sci.* **42** 765-776

——— 1975 Cytological studies in *Fimbristylis* (Cyperaceae); *Cytologia* **40** 177-183

——— 1977 Autotetraploidy in *Fimbristylis falcata* (Vahl) Kunth (Cyperaceae); *Proc Indian Acad Sci* **85B** 21-24

Rath S P and Patnaik S N 1978 Cytological studies in Cyperecae with with special reference to its taxonomy II; *Cytologia* **43** 643-653

Santapau H and Henry A W 1973 *A Dictionary of the Flowering Plants of India;* (New Delhi: Pub. & Inf. Direct. CSIR)

Sanyal and Sharma A 1972 Cytological studies in Indian Cyperaceae I Trib Scirpeae; *Cytologia* **37** 13-32

Sharma A and Sarkar A K (Ed) 1967-68 Chromosome number reports of plants in *Annual Report, Cytogenetics Laboratory*, Department of Botany University of Calcutta; *The Res Bull* **2** 38-48

Sharma A K and Bal A K 1956 A cytological investigation of some members of the family Cyperaceae; *Phyton* **6** 7-22

Sharma B R 1962 Cytology of Cyperaceae; *Proc 49th Indian Sci Cong Sess.* Part III. Abstracts. pp 337-338

Tanaka N 1937 Chromosome studies in Cyperaceae I; *Cytologia Fujii Jub. Vol.* 814-821

——— 1939 Chromosome studies in Cyperaceae VII; Chromosome number and pollen development of *Fimbristylis; Bot. Mag* (Tokyo) **53** 480-487

Willis J C 1966 *A Dictionary of the Flowering Plants and Ferns* 7th ed Revised by H K Airy Shaw (London: Cambridge University Press)