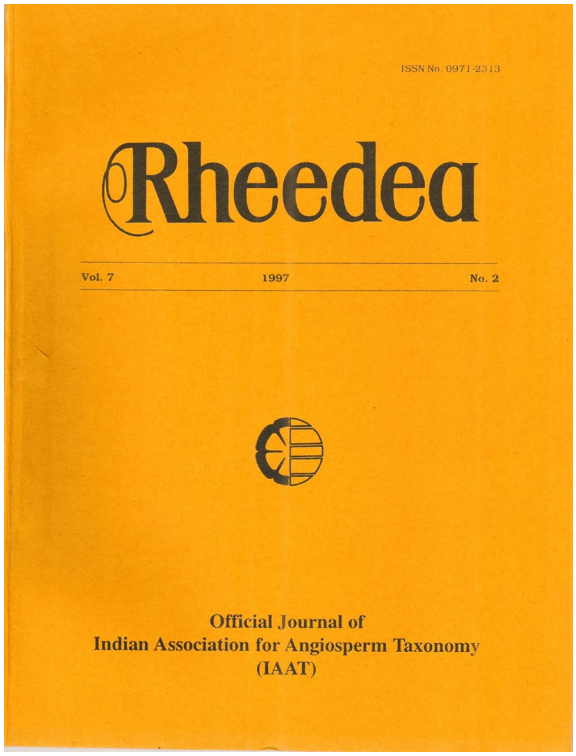
RHEEDEA
Journal of the Indian Association for Angiosperm Taxonomy

Vol. 7(2): 93–99 (1997)
ISSN: 0971-2313 (Print edition)
ISSN: 2582-2438 (Online edition)

Achene micromorphology as a systematic aid to the taxonomic recognition of *Cyperus cytotypes*

Daniel E. Wujek, Paramjeet Cheema, Bir S.S. & F.J. Menapace



How to cite:

Wujek D.E., Cheema P., Bir S.S. & F.J. Menapace. 1997. Achene micromorphology as a systematic aid to the taxonomic recognition of *Cyperus cytotypes*. *Rheedea* 7(2): 93–99.

https://dx.doi.org/10.22244/rheedea.1997.07.02.06

Published in print: 31.12.1997 *Published Online*: 01.01.2022

Published by Indian Association for Angiosperm Taxonomy
This volume of Rheedea is published with partial financial assistance from Department of Science and Technology, Government of India, New Delhi

Rheedea Vol. 7(2): 93-99. 1997

Achene micromorphology as a systematic aid to the taxonomic recognition of *Cyperus* cytotypes

Daniel E. Wujek
Department of Biology, Central Michigan University,
Mt. Pleasant, Michigan 48859, U.S.A.

Paramjeet Cheema, S.S. Bir
Department of Botany, Punjabi University,
Patiala - 147 002, India

and

Francis J. Menapace
Department of Biology, University of North Alabama, Florence,
Alabama 35632, U.S.A.

Abstract

Achenes of *Cyperus compressus* L. and *C. difformis* L. were examined employing scanning electron microscopy to ascertain if micromorphological characters can be used to delimit conscpecific cytotypes. Acid-treated achenes with their cuticle and outer periclinal walls removed revealed diagnostic micromorphological characters between the euploid cytotypes of *C. compressus*. No diagnostic micromorphological achene characters were observed between the euploid or, aneuploid cytotypes of *C. diffomis*. Our results support the utilization of achene micromorphology as a potential tool for the taxonomic recognition of euploid *Cyperus* cytotypes.

INTRODUCTION

Given the relative consistency of karyotypic characters between conspecific individuals within tracheophyte taxa, ploidy levels have been used extensively as a systematic tool. In fact, chromosome counts are becoming a standard component of taxonomic descriptions within modern floras (e.g., *Flora of North America*). However, for a number of tracheophyte families, the existence of cytotypes is well documented. Among the Cyperaceae, lengthy euploid (e.g., *Eleocharis*: Strandhede, 1958, 1965) and aneuploid (e.g., *Carex*: Heilborn, 1924; Tanaka, 1937, 1939) series are known. With regard to Indian *Cyperus*, both euploid and aneuploid conspecific cytotypes have been published (Bir *et al.*, 1988, 1992; Cheema *et al.*, 1993; Cheema & Bir, 1994). *Cyperus* cytotypes often possess consistent but cryptic vegetative macromorphological and micromorphological character differences. The dilemma

for cyperologists is whether or not such cryptically distinct cytotypes are worthy of taxonomic recognition.

Over the past few decades, applying the widely accepted principle that fruit characters are inherently more conservative than vegetative characters, cyperologists have utilized achene micromorphology in the resolution of systematic problems (Menapace *et al.*, 1986; Wujek & Menapace, 1986; Menapace & Wujek, 1987; Menapace, 1993). Such information has proven to be of particular value below the generic rank. Recent studies of *Cyperus* have shown sufficient achene micromorphological differences to warrant their use systematically (Denton, 1983; Wujek *et al.*, 1992).

Although prior *Cyperus* cytotype studies have shown consistent phenetic vegetative variation correlating with changes in chromosome number (Bir *et al.*, 1988, 1992; Cheema *et al.*, 1993; Cheema & Bir, 1994), to date, no study has investigated achene micromorphological variation among conspecific cytotypes. In this paper, taking into account both the occurrence of *Cyperus* cytotypes, and the proven potential of achene micromorphology in *Cyperus* systematics, we will address the question: Do the achenes of selected *Cyperus* cytotypes bear diagnostic micromorphological characters?

MATERIALS AND METHODS

Achene preparation and observations were conducted as previously described (Wujek *et al.*, 1992). Two to four specimens of each cytotype of *Cyperus compressus* L. and *C. difformis* L. were investigated covering as wide a geographic distribution as possible (Table 1). A minimum of five achenes from each specimen were examined.

RESULTS

Cyperus compressus L., Sp. Pl. 46. 1753, emend. Dandy in Exell, Cat. S. Tome 357. 1944.

Cytotype: n = 56 (Fig. 1:A,B)

Two types of achene wall cells are recognized - those bearing a large central nodule, and those that are devoid of a large central nodule. At the apex of each nodule 2-6 spines have been observed (Fig. 1:B). Nodules devoid of spines represent an artifact in which the spines were incidentally removed during preparation. In both cell types, the lumen is slightly concave, and the anticlinal cell walls are entire to crenulate.

Cytotype: n = 64 (Fig. 1: C,D)

One type of achene wall cell is recognized. Only nodulated cells bearing apical spines are present. The anticlinal walls and lumen are identical to cytotype n = 56.

Pattern differences were significantly different using the Chi Square Test of Association ($p < .0001$).

Table 1: Voucher Specimens

Cytotypes	PUN Accession No.
Cyperus compressus L. n = 56	31382
	34966
	34999
	35406
Cyperus compressus L. n = 64	26156
	26157
	26158
	35405
Cyperus difformis L. n = 9	34966
	34999
Cyperus difformis L. n = 17	35000
	35001
	35190
Cyperus difformis L. n = 18	34965
	35191

Cyperus difformis L., Cent. Pl. 2: 6. 1756.

Cytotype: n = 9, n = 17, n = 18 (Fig. 2)

One type of achene wall cell is recognized. All three cytotypes possess cells with a highly concave lumen bearing peripheral pits. Within the lumen a large central nodule (Fig. 2:A,C,E), with radiating apical spines (Fig. 2;B,D,F) are present.

DISCUSSION

The accumulative morphological and physiological effects of a polyploid series within tracheophytes is well documented (Stebbins, 1950). Although variable, the most universally observed changes include: a general increase in cell size, an increase in vigor, and a decrease in fertility.

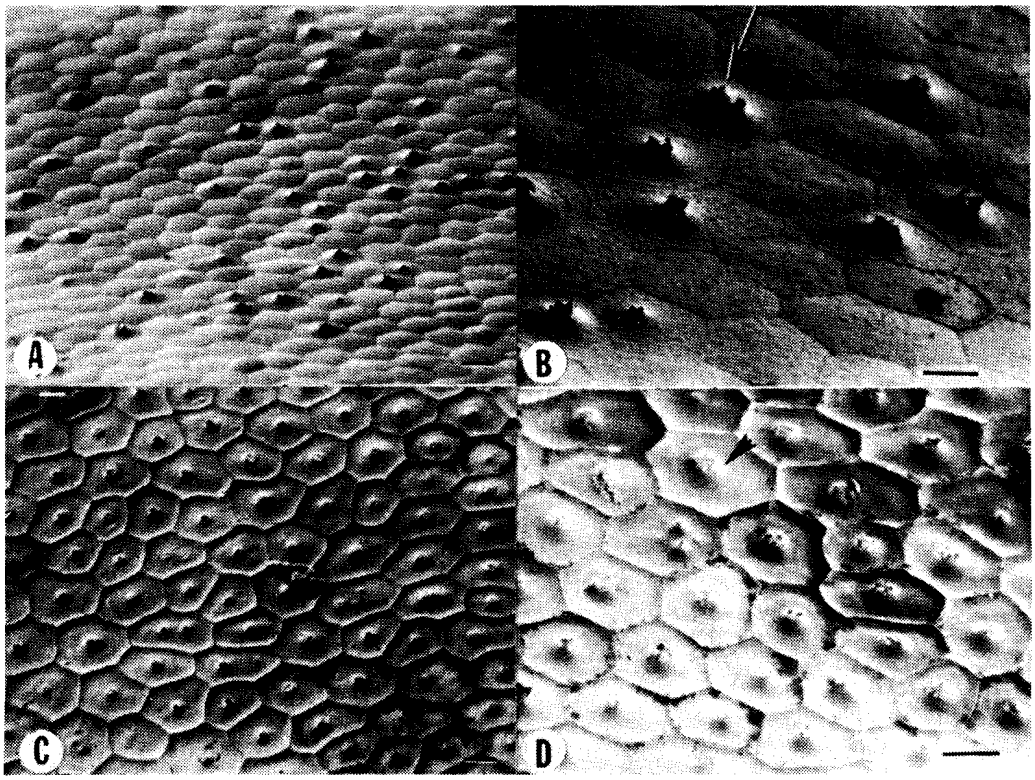


Fig. 1. Scanning electron micrographs of *Cyperus compressus* achene surface. A,B. Cytotype with n = 56; C,D. Cytotype with n = 64. (Arrowhead = central nodule; Arrow = apical spines. Scale bars = 10 μm).

The known euploid cytotypes of *C. compressus* include: n = 56, and n = 64, in which the base number is x = 8 (Bir *et al.*, 1988; Bir *et al.*, 1992). Bir *et al.* (1988) discovered that these cytotypes were phenotypically distinct utilizing vegetative macromorphological and micromorphological characters. Cytotype n = 56, is erect in growth habit, bears comparatively thin culms, and smaller leaf epidermal cells, than the prostrate n = 64 cytotype.

The achene micromorphology correlates with the vegetative morphology in that the number of nodulated cells increases with chromosome number. All cells of the n = 64 cytotype bear a central nodule (Fig. 1: C,D), while the n = 56 cytotype possesses both nodulated and non-nodulated cells (Fig. 1:A,B). Accordingly, the euploid cytotypes of *C. compressus* bear diagnostic micromorphological achene characters.

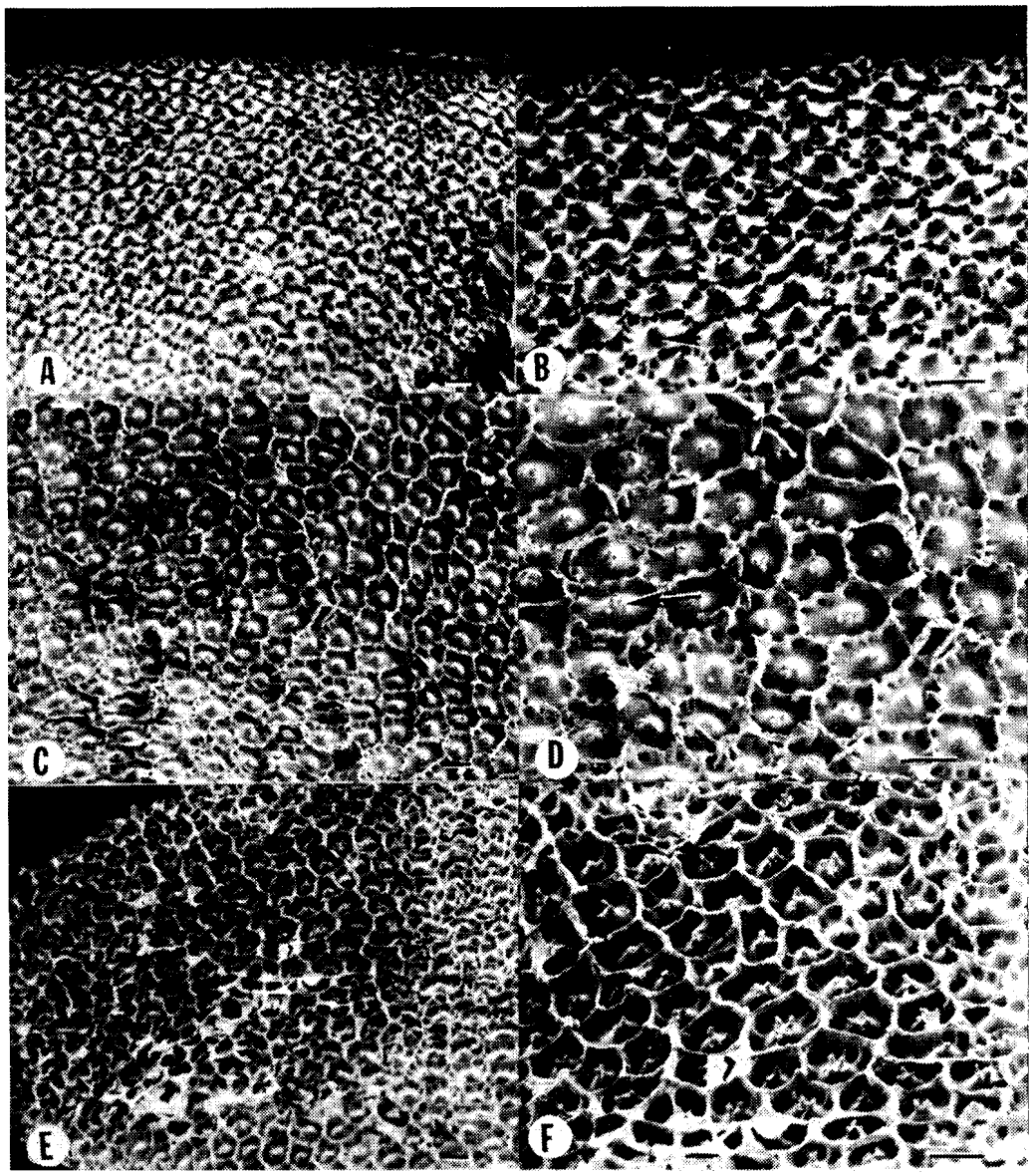


Fig. 2. *Cyperus difformis* achene surface. A,B. Cytotype with n = 9; C,D. Cytotype with n = 17; E, F. Cytotypes with n = 18 (Arrowhead = central nodule; Arrow = apical spines. Scale bars = 10 μm).

The cytotypes of *C. difformis* include: n = 9, n = 17, and n = 18. The cytotype n = 9 and n = 18 are elements of a euploid series in which the base number is x = 9; while n = 17 is an aneuploid of n = 18. Cheema and Bir (1994) have reported distinct and consistent vegetative morphological differences between the cytotypes. Within *C. difformis* there is a correlated increase in vegetative stature with an increase in chromosome number.

In contrast to *C. compressus*, no diagnostic micromorphological characters were noted between the achenes of the euploid or aneuploid cytotypes of *C. difformis*.

Stebbins (1950), Rogers and Appan (1969), and others, have advocated the recognition of euploid cytotypes as distinct species, given that they are reproductively isolated. Mehra (1982), in contrast, has emphasized that a cytotype should be granted taxonomic status only when the cytotype shows sharp and easily identifiable macromorphological characters. The problem confronting cyperologists is what constitutes "sharp and easily identifiable macromorphological characters." It is our contention that only those cytotypes bearing salient vegetative macromorphological characters, in conjunction with salient achene micromorphological characters, are worthy of taxonomic recognition.

Our results have shown that the achene micromorphology of *Cyperus* euploids may be distinct. It is our contention, taking into account the accepted conservative nature of fruit characters, that those cytotypes bearing macromorphological vegetative differences, in conjunction with salient achene micromorphological differences, are worthy of taxonomic recognition (e.g., *C. compressus* cytotypes). Consequently, our results suggest that a revision of *C. compressus* with the taxonomic recognition of its euploids, is in order.

Acknowledgements

The first author thanks Eric Duffield for his SEM contributions, Central Michigan University Graphics Production for photographic assistance, and Dr. R. Hogdson for statistical assistance. This study was in part supported by a CMU Faculty Research and Creative Endeavors Committee Grant.

Literature cited

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

Bir, S. S., P. Cheema, & M. Sidhu. 1992. Chromosomal diversity in members of genus *Cyperus* Linn. from northwest India-I. Section *Kyllingia* (Rottb.) Endl. *Jour. Pl. Sci. Res.* 8: 4-8.

Cheema, P., S. S. Bir, & M.K. Sidhu. 1993. Chromosomal variabilities in *Cyperus* Linn. from NW India. *Cytologia* 58: 345-349.

Cheema, P. & S. S. Bir. 1994. Aneuploidy in sedges: morphological distinctness of cytotypes from Punjab, NW India. *In*: T.A. Aarma, S.S. Saini, M.L. Trivedi, & M. Sharma (Eds.), *Current Research in Plant Sciences*. Bishen Singh Mahendra Pal Singh, Dehra Dun. pp.263-269.

Denton, M. F. 1983. Anatomical studies of the *Luzulae* group of *Cyperus* (Cyperaceae). *Systematic Botany* 8: 250-262.

Heilborn, O. 1924. Chromosome numbers and dimensions, species-formation and phylogeny in the genus *Carex*. *Hereditas* 5: 129-216.

Mehra, P. N. 1982. *Cytology of East Indian Grasses*. New Delhi.

Menapace, F. J. 1993. Achene micro-morphology as a systematic aid to the series placement of Svenson's undesignated *Eleocharis* (Cyperaceae) species. *Rhodora* 95: 214-224.

Menapace, F. J. & D.E. Wujek. 1987. The systematic significance of achene micromorphology in *Carex retrorsa* (Cyperaceae). *Brittonia* 39: 278-283.

Menapace, F. J., D. E. Wujek. & A. A. Reznicek. 1986. A systematic revision of the genus *Carex* (Cyperaceae) with respect to the section *Lupulinae*. *Can. J. Bot.* 64: 2785-2788.

Rogers, D. J. & S. G. Appan. 1969. Taximetric methods for delimiting biological species. *Taxon* 18: 609-624.

Stebbins, G. L. 1950. *Variation and Evolution in Plants*. Columbia University Press, New York. pp.643.

Strandhede, S. O. 1965. Chromosome studies in *Eleocharis* subseries *Palustres*. III. Observation on western European taxa. *Opera Bot.* 9: 1-86.

Wujek, D. E. & F. J. Menapace. 1986. Taxonomy of *Carex* section *Folliculatae* using achene morphology. *Rhodora* 88: 399-403.

Wujek, D. E., S. K. Varma, & R. A. Ruhlman. 1992. Achene micromorphology of some Indian Cyperaceae (*Cyperus, Fimbristylis, Pycreus, Scirpus* and *Scleria*). *Asian Jour. Pl. Sci.* 4: 1-19.