CYTOGENETICS OF PLANTS & ITS RECENT APPROACHES

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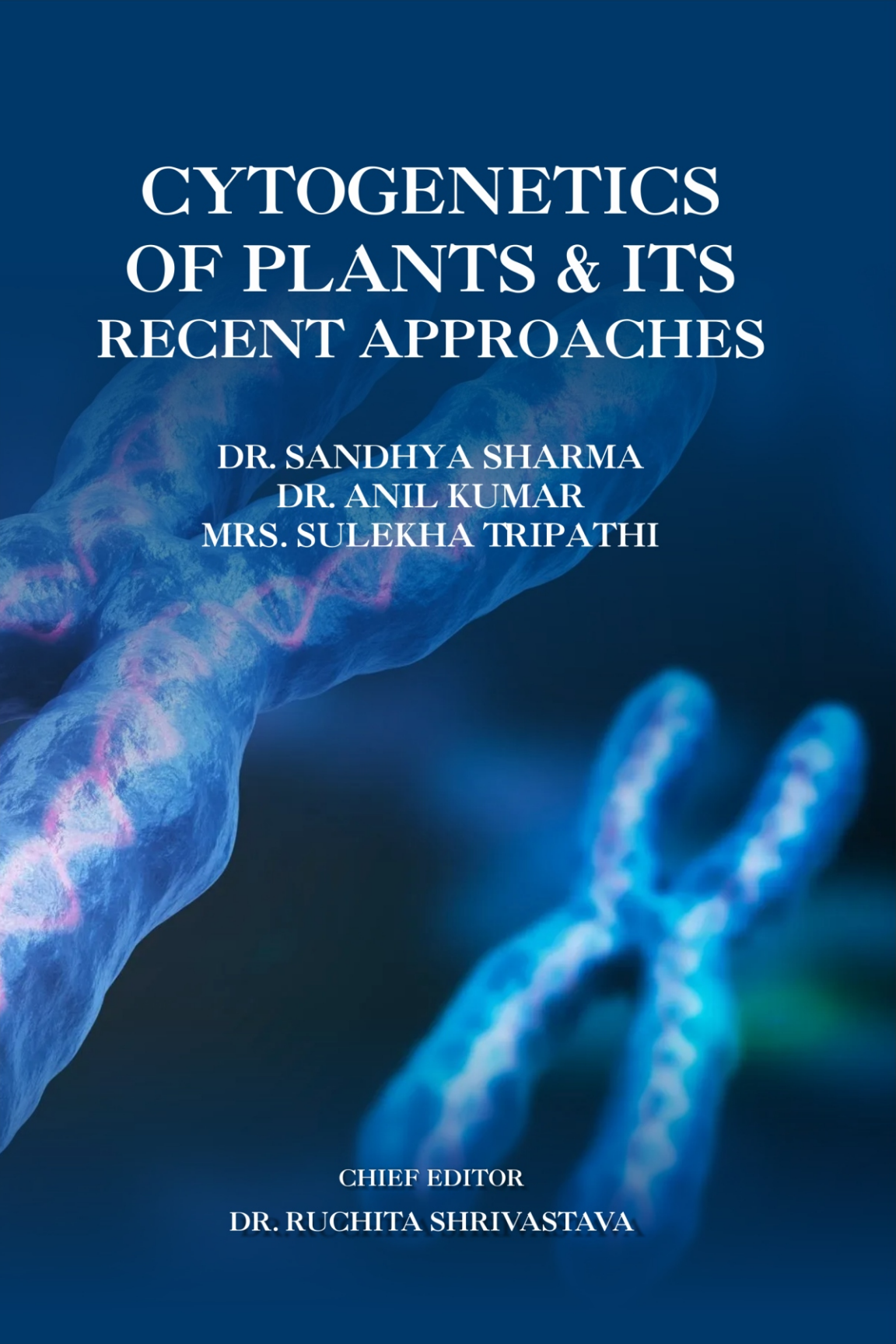

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CYTOMORPHOLOGICAL INVESTIGATIONS ON TWO FORMA OF *CHARA SOCOTRENSIS* FROM WESTERN MAHARASHTRA

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ABSTRACT

Present paper deals with morphological and cytological comparison between two forma (by RDW) viz. f. *pashanii* and f. *nuda* of *Chara socotrensis*. Of the six species of *Chara*, two species are ecorticated. Among the ecorticates *Chara socotrensis* has been least explored. Present communication deals with cytomorphological comparison between *Chara socotrensis* f. *pashanii* and f. *nuda*. Both of these forma vary morphologically as well as cytologically. Beside few variations in the chromosome compliment these two morphological resemble considerably. An attempt is being made to investigate between these two indigenous forma previously recognized as independent species.

Keywords – *Chara*, *C. socotrensis,* f. *pashanii*, f. *nuda,* cytomorphology.

INTRODUCTION

Charophytes are the macroscopic algal forms drawing extensive attention of phycologist now-a-days world over. Work on cytology of Indian charophyta was initiated late in the 20th century. (Sunderlingam 1946, Khan and Sarma 1967, Bhatnagar 1988, Chatterjee 1976, Ramjee and Sarma 1971, Sarma 1984, Sinha. and Sinha. 1992, Verma. 1988, Gonzalvis 1963, Bharathi. and. Chennaveraiah 1980). The central part of the India was surveyed for morphology of these macrophytes by Dixit (1931, 1935, 1940a, 1940b, 1942), Vaidya (1967), Vaidya and Gonzalves (1963), Bharati

and Chennaveraiah (1980) and Kamat (1965). Jawale. (1986), Patil and Chaugule (1992), Karande and Chaugule (1998) However no information on cytology of charophytes from Maharashtra is available. In order to update knowledge of taxonomy and cytology of the charophytes from Maharashtra this attempt has been made.

MATERIAL AND METHODS

Satara district occupies important position owing to the famous hill stations as well as "throne of king Shivaji". District lies between 17^0 50′ and 18^0 11′ North latitude and 73^0 31′ to 74^0 75′ East longitude along the Sahyadri ranges. It has an area of 10417 sq. km., with 11 administrative tahsils. The district has a compact shape with an east west stretch of about 144 km., and north south about 120 km. Plants were collected during post monsoon season from different locality. Morphological observations were made and plants were preserved in 4% formaldehyde solution. Identification was made using monographs by Wood and Imahori 1965, Zaneveld 1940, Pal and Kundu1960 and Subramanian 2002. Cytological work was carried out using antheridial filaments. Voucher specimens and slides have been deposited in Department of Botany, Y. C. Institute of Science, Satara.

OBSERVATIONS

***Chara socotrensis* f. *pashanii* (Dixit) R. D. W.**

Plants monoecious, 4 – 15 cm. high.Stem slender, erect, stout. 234 - 460 µm. in diameter; internodes 0.5 – 2 cm long 1 – 3 times as long as branchlets. Stipulodes present in 1 tier but rudimentary. Branchlets 10 – 12 in a whorl, 0.7 to 2 5 cm. long; 2 – 5 segments; terminal segment one celled conical, acute, the lower one to two segment short and curved. Cortex entirely absent. Bract cells present only at fertile nodes 2, 115 – 180 µm. long. Bracteoles 2, shorter or nearly equal to the mature oogonium 215 – 420 µm. long.Gametangia conjoined and aggregate at lowest 1 – 2 branchlet nodes, usually 2 antheridia below 1 – 2 oogonia. Oogonia 1 – 2 together. Oogonium 360 – 805 µm. long, 175 - 530 µm. broad (incl. coronula), 400 - 820 µm. long 200 - 580 um wide (excl. coronula) convolutions 9; coronula 60 – 150 µm. high, 146 - 175 µm. wide. Oospores orange to black in colour 215 -270 µm. long, 210 – 270 µm. wide; striae of 8 – 10 prominent ridges; fossa 58 µm. across; Antheridia 205 – 265 µm. in diameter; octosutate.

C. socotrensis f. *pashanii* was abundant in its occurrence around Satara and within Satara district than other species of charophytes. This species was collected from following localities:

1. Kavathe, Tal. Wai, Satara.
2. Ozarde, Tal. Wai, Satara.
3. Medha, Tal Jawali, Satara.
4. Godoli Satara.
5. Parali Satara.
6. Pateghar, Satara.
7. Pateshwar, Satara.
8. Jarandeshwar, Satararoad
9. Rajewadi, Degoan, Satara
10. Masur, Tal.Karad, Satara.
11. Urmodi Dam, Satara.

In our survey of charophytes from Satara district, this species occurred at wide localities. The plants always occurred along the margins of pools, puddles and on wet mud where the soil was rich in calcium. Compared with the specimen described by R.D.Wood, and that originally described by S.C.Dixit, most of our specimens showed some distinguishing features like downwardly growing corticating threads running over the main axes and presence of stipulodes.

***Chara socotrensis* f. *nuda* (Pal) R.D. W.**
***Chara socotrensis* f. *nuda* (Pal) R.D.W.**

Plants, monoecious, 3 – 12 cm. high, axes slender 293 – 410 µm. in diameter, internodes c 0.3 – 0.7 cm. long, cortex haplostichous, stipulodes rudimentary in one tier. Branchlet 7 – 9 in a whorl, 0.3 – 0.9 cm. long, segments 2 – 3, totally ecorticate, end segment blunt, bract cells 2 unilateral, bracteoles 2 small. Gametangia conjoined present at two lowest branchlet node, oogonia 366 – 659 µm. long (excl. coronula), 245 – 513 µm. wide, oogonia 513 – 777 µm. long (incl. coronula) and 250 – 513 µm. wide; convolutions 10 – 12; coronula 88 – 147 µm. high, 175 – 250 µm. wide. Oospores black, 513 – 586 µm. long, 293 – 498 µm. wide, striae – 10 with prominent ridges, fossa 58 – 74 µm. Antheridia 263 – 293 µm. in diameter.

As compared to *C. socotrensis* f. *pashnii, C. socotrensis* f. *nuda* occurs rarely in Satara district. This species was collected from following localities:

1. Pateghar, Satara.
2. Urmodi Dam, Satara.

3. Godoli Satara.

Our specimen showed some distinguishing features like stipulodes are rudimentary and alternate, height and axes diameter was more, presence of 2 bracts and bracteoles, larger antheridia, short oogonium, height and width of coronula was more. Though it is ecorticated species, imperfect cortication was seen at nodal region of some *nuda* specimens.

Table No. 1: Morphological difference between *Chara socotrensis* f *nuda* (Pal) R.D.W. and *Chara socotrensis* f. *pashanii* (Dixit) R. D. W.

Sr. No.	Character	*Chara socotrensis* f *nuda* (Pal) R.D.W.	*Chara socotrensis* f. *pashanii* (Dixit) R. D. W.
1	Habit	Monoecious, 3 – 12 cm.	Monoecious, 4 – 15 cms long
2	Axes (diameter)	293 – 410 µm.	Slender, stout 234 -460 µm. in diameter
3	Internodes	0.3 – 0.7 cm. Nearly equal or longer than ranchlets	0.5 - 2 cm shorter than branchlet
4	Stipulodes	1 tier rudimentary	Rudimentary in 1 tier.
5	Cortex	Imperfect	Absent
6	Branchlets Number Length Segments	 7 – 9 in a whorl 0.3 -0.9 cm. 2 – 3	 10 -12 in a whorl 0.7 – 2.5 cm long 2 – 5
7	Bract cells	2, 146-190µm. long 45µm. wide	2 , only at fertile nodes

8	Bracteoles	2	2, shorter or nearly equal to mature oogonium.
9	Gametangia	Conjoined at lowest 2 branchlet nodes	Conjoined, geminate at lowest 1 – 2 nodes, branchlet nodes.
10	Oogonia Length Breadth Convolutions	Soliatary, 513-777µm. long, 245-513µm. wide.	1 – 2 together 360 – 805 µm. 175 – 530 µm. 9
11	Coronula Height Width	 88-147µm. high 175-250µm. wide.	 73 – 100 µm. 146 – 175 µm.
12	Oospore Colour Length Breadth Ridges Fossa Membrane	 Black 513 – 586 µm 293 – 498 µm 10 58 – 74 Not seen	 Orange to black 215 – 270 µm. 210 – 270 µm. 8 – 10 58 µm. Not seen
13	Antheridia (diam.)	Solitary 263 -293 µm. in diameter, Octoscutate	205 – 265 µm. octoscutate

Table No. 2: Measurements of chromosomes in *Chara socotrensis* f. *pashanii* (Dixit) R. D. W.

No.	Length of chromo. arms µm. Long arm	Short arm	Total Length µm.	Centromeric Position	Type of chromosome
1.	3.3	3.3	6.6	Metacentric	Long
2.	3.3	3.3	6.6	Metacentric	Long
3.	3.3	2.7	6.0	Submetacentric	Long
4.	3.3	2.7	6.0	Submetacentric	Long
5.	3.3	2.3	5.6	Submetacentric	Long
6.	3.3	2.3	5.6	Submetacentric	Long
7.	2.3	2.3	4.6	Metacentric	Medium
8.	2.3	2.3	4.6	Metacentric	Medium
9.	1.7	1.7	3.4	Metacentric	Short
10.	1.7	1.7	3.4	Metacentric	Short
11.	1.3	1.3	2.6	Metacentric	Short
12.	1.3	1.3	2.6	Metacentric	Short
13.	2.7	--	2.7	Telocentric	Short
14.	2.7	--	2.7	Telocentric	Short

Table No. 3 : Classification of Chromosomes - *Chara socotrensis* f. *pashanii*

Chromosome type	Number of Chromosome	Length in µm.	Karyotype formula
A	6	5.6 – 6 .6 µm.	

B	2	4.6 µm.	A6 + B2 + C6 L(m_2,sm_4) + M(sm_2) + S(m_2,t_2)
C	6	3.4 – 2.7 µm.	

Formula – **L (m_2, sm_4) + M (sm_2) + S (m_4, t_2)**

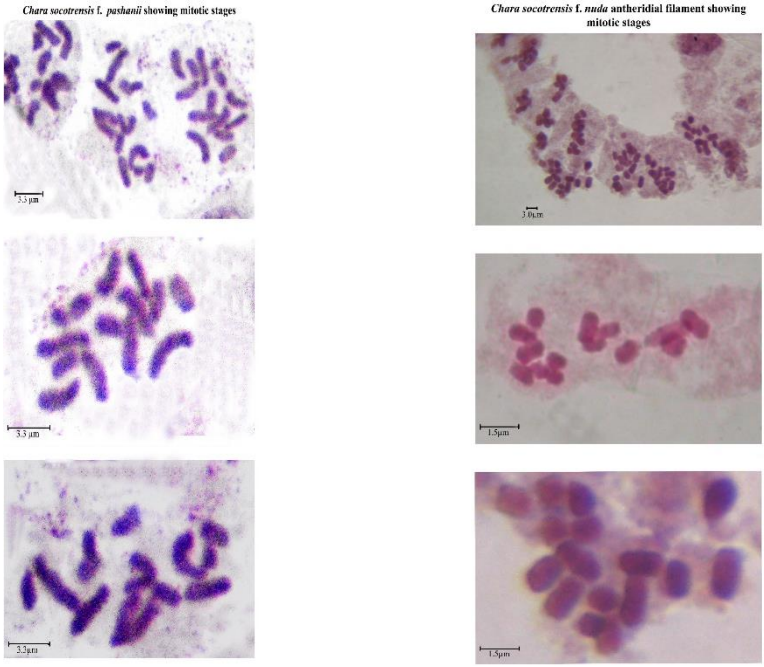
Table 4: Measurements of chromosomes in *Chara socotrensis* f. *nuda* (Pal) R.D.W.

No.	Length of chromo. arms µm. Long arm	Short arm	Total Length µm.	Centromeric Position	Type of chromosome
1.	2.9	2.9	5.8	Metacentric	Long
2.	2.9	2.9	5.8	Metacentric	Long
3.	2.9	2.9	5.8	Metacentric	Long
4.	2.9	1.5	4.4	Submetacentric	Long
5.	1.5	1.5	3.0	Metacentric	Medium
6.	1.5	1.5	3.0	Metacentric	Medium
7.	1.5	1.5	3.0	Metacentric	Medium
8.	1.5	1.5	3.0	Metacentric	Medium
9.	1.5	1.5	3.0	Metacentric	Medium
10.	1.5	1.5	3.0	Metacentric	Medium
11.	1.5	1.5	3.0	Metacentric	Medium
12.	1.5	1.5	3.0	Metacentric	Medium
13.	1.5	--	1.5	Telocentric	Short
14.	1.5	--	1.5	Telocentric	Short

Table No. 13: Classification of Chromosomes - *Chara socotrensis* f. *nuda*

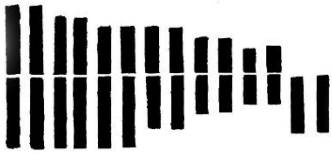
Chromosome type	Number of Chromosome	Length in µm.	Karyotype formula
A	4	5.8 - 4.4 µm.	A4 + B8 + C2 $L(m_3, sm_1) + M(m_8) + S(t_2)$
B	8	3.0 µm.	
C	2	1.5 µm.	

Formula – L (m_3, sm_1) + M (m_8) + S (t_2)

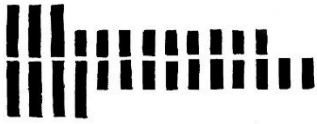


Photoplate showing Chromosomes in *Chara socotrensis* f. *pashanii* (Dixit) R. D. W. and *Chara socotrensis* f. *nuda* (Pal) R.D.W.

IDIOGRAMS



Idiogram of *Chara socotrensis* f. *pashanii*



Idiogram of *Chara socotrensis* f. *nuda*

DISCUSSION

Satara district can be divided into two climatic zones. Of these the western hilly parts reveals the abundance of ecorticated species of *Chara* viz *C. socotrensis* f. *pashanii* and *C. socotrensis* f. *nuda*. Khan and Sarma have opined that *Chara socotrensis* f. *nuda* has been reported only from India and Burma while f. *pashani* restricted to India and Malaysian country. Our efforts were to identify the chromosome number in both the species. We could successfully carry out the cytology of both of them and found the chromosome number n = 14 in both of the species. The report on chromosome number of f. *nuda* is the first report from Maharashtra. A large number of variations in morphology have been found in f. *pashanii.* This may be because of environmental conditions where the plants grow. Usually the plants were collected along the periphery of pools and puddles or in the mud with ample water. On the other hand plants of forma *nuda* were seen growing submerged in water. Both of the forma were initially considered to be individual species (Pal et al 1962). The merger of two species into a single species viz. *socotrensis* can be justified not only on the basis of chromosome number but also on morphology. Very few characters differentiate them individually. Besides the geminate gametangia and length of branchlets there are no more differences according to Wood Imahori. Our observations after screening of large number of specimens revealed that there is tendency of forming corticated threads in *Chara socotrensis* f. *pashanii*. The cortication thus may be said vestigial or imperfect but definitely there is tendency of cortication in these plants. *Chara pashanii* was originally described by Dixit (1935) from a ditch at Pashan near Pune. After that Vaidya and

Gonzalves (1963) made a report on the occurrence of the species from Aji river Gujarat. After Dixit a sole report of the species has been made by Chaugule and Patil (1992) from the foothills of Sinhagadh, an offshoot of Sahyadri and other localities. Khan and Sarma (1981) commented on this species as an endemic. However, our search of the charophytes along the western parts of Maharashtra has shown that the species occurs abundantly.

Chara socotrensis f *nuda,* studied in the present investigation was originally described from Burma by Pal (1932) as a distinct species viz. *Chara nuda*. Later collections of this species were made from different parts of India but variable characteristics of the species have been recorded. Sinha and Verma (1970) and Ramjee and Sarma (1971) reported chromosome number, n=14 in populations of this species growing in Ranchi, Bihar and Madhya Pradesh.

The species is reported to be endemic to India, Burma and Malaya (Khan and Sarma, 1981). In this forma Sinha and Verma (1970) and Sinha and Sinha (1972) showed the chromosome number n = 14. Chatterjee (1976) detected two cytotypes of this forma. One of these cytotypes showed n=28 chromosomes and other showed normal n = 14. Present material from Satara showed chromosome number n=14. The karyotype of the specimen is quite distinctive. Both forma *nuda* and *pashanii* of *C. socotrensis* are ecorticate and monoceious species however; they differ morphologically in many respects from each other. In f. *nuda* stiopulodes are rudimentary and alternate while they are absent in f. *pashanii.* Bracts and bracteoles are also present in f. *nuda*, though it is ecorticated species, imperfect cortication is seen at nodal region of some specimens.

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CYTOGENETICS OF PLANTS & ITS RECENT APPROACHES

Cytogenetic techniques go beyond the simple detection of chromosome aberrations. The intensive development of molecular biology and the significantly improved microscopic visualization and evaluation methods constituted significant support to traditional cytogenetics. Over the past years, distinct approaches have allowed an understanding the mechanisms of formation, structure, and genetic activity of the micronuclei. Although there are many studies on this topic in humans and animals, knowledge in plants is significantly limited. This article provides a comprehensive overview of the current knowledge on micronuclei characteristics in plants. We pay particular attention to how the recent contemporary achievements have influenced the understanding of micronuclei in plant cells. Together with the current progress, we present the latest applications of the micronucleus test in mutagenesis and assess the state of the environment.

Plant cytogenetics has thrived, offering vital contributions to genomics endeavors by mapping marker sequences, identifying contig gaps, and unveiling genome rearrangements. In this review, we trace the evolution of plant cytogenetics from its inception through the molecular biology and genomics epochs. Noteworthy enhancements in chromosome preparation, exemplified by extended fiber-FISH techniques, have substantially heightened axial resolution thresholds.

Concurrently, advancements in imaging and signal amplification technologies have bolstered our capacity to detect minute gene-sized probes. Integrating traditional FISH methodologies with chromatin immunocytochemistry has expanded the repertoire of plant cytogenetics, enabling deeper insights into genome architecture and organization. We discuss these breakthroughs alongside select instances that underscore the efficacy of plant cytogenetics in steering genome initiatives.

Authoritative and pragmatic, the book serves as an invaluable tool for plant scientists engaged in molecular and evolutionary biology, breeding, systematics, and plant -omics research.

Dr. Ruchita Shrivastava was the Ex – faculty (Horticulture, Adhoc) at Department of Botany, Govt. Homescience PG Lead College, Narmadapuram (M.P.). She has pursued her M.Sc. & Ph.D. in Botany from Barkatullah University, Bhopal. She has attended more than 10 National & International Seminars & Webinars and also published more than 35 research papers and 04 book chapter in National and International Journal and book. She has also research experience in quantitative & qualitative extraction of medicinal plants of Madhya Pradesh.

She also won the best researcher award in 2022 by Research Education Solution (affiliated by GOI & AICTE). Currently she is President of Society for Advanced Research in Plant Science registered & recognized by Govt. of Madhya Pradesh Society Act.

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