

# BIOPROSPECTING OF ALGAE

*(Prof J.P. Sinha Memorial Volume)*

**Editors**

**M.N. Noor**

**S.K. Bhatnagar**

**Shashi K. Sinha**

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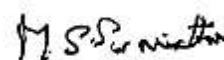
## FOREWORD

Algae is an important group of autotrophic plants which include micro and macroorganisms. In the recent time great emphasis is being given to this group of plants because of its great potential in the production of green energy, nutraceuticals, cosmetic products, biofertilizer for sustainability of agriculture, medicines and health safe food stuffs.

Conservation of environment, water, soil and energy are the biggest challenges before the scientific community now a days apart from the agricultural production. Green energy is the best alternative which can be achieved by using algal strains with high accumulation and synthesis of fatty acids. Omega 3 fatty acids and PUFAs are the essential ingredient of human food and animal foodstuff which can be supplemented by algae. Besides this the use of algal strains as bio-fertilizer in agriculture need attention to replace or supplement chemical fertilizer which is dreadful for the global health.

The Editors of BIOPROSPECTING OF ALGAE have brought together many issues related to algae in the form of 27 elaborated chapters authored by known algologists. Spin: lino; bioplastic. biotite!. phycoremediation, applications of algal strains in various fields are some potential areas covered in the book by the Editors. I am confident that this book will be quite useful to the agricultural scientists, students, researchers and will facilitate the utilization of this important plant group of algae for human welfare.

The Editors deserve appreciation for timely publication of the book in a period when the entire world is focusing on environmental issues, green energy and potential health food.

A handwritten signature in black ink, appearing to read 'M.S. Swaminathan'.

**M S Swaminathan**

# PREFACE

Prof Jwala Prasad Sinha was born on January 2, 1921 and did his post graduation from Banaras Hindu University in 1947. Prof Sinha went to London for pursuing his Ph D degree under the able leadership of Prof M B E Godward, Queen mary College, University of London on the topic “Cytological and cultural study of some members of Cladophorales and Oedogoniales” and got his degree in 1958.



After returning back from London, Prof Sinha joined as Assistant Professor of Botany in Patna University in 1947 and served as Head from 1952 to 1961. He became Professor and Head ,University Department of Botany, Ranchi University and served from 1961 to 1981. Prof Sinha worked as Dean, faculty of Science also in Ranchi University.

He remained Member, Advisory committee of Standing Commission of Scientific and Technical Technology, Government of India, Ministry of Education Committee, Bihar state University Commission for translation of standard text books in Hindi and Director, Hindi Books Publication Cell in Botany, sponsored by the Ministry of Education, Government of India.

Professor Sinha published researches in the journals of International repute besides participating actively in National and International Conferences.

Prof Sinha supervised Prof M N Noor in 1965, Prof R N Das in 1968, Prof B N Verma in 1969, Prof Sandhya Sinha in 1974 and Dr K D N Akhouri. Prof Sinha left this immortal world for heavenly abode on 10<sup>th</sup> November 1994.

On the initiative of Prof M N Noor, the Editors decided to bring out Prof J P Sinha Memorial Volume and the Internationally recognized Society for Plant Research took up this task. Society for Plant Research is globally known for its official publication VEGETOS: An International Journal of Plant Research and Biotechnology and the details can be surfed at [www.vegetosindia.org](http://www.vegetosindia.org). The book is comprised of 27 chapters by renowned algologists and has covered all major aspects of algal research.

The Editor salute a legendary Botanist and wish that the faculty, students and researchers in the filed of Botany, Algology, Algal Biofertilizer, Algae Biofuel and related fields will take advantage of this compendium.

**M N NOOR**  
**S K BHATNAGAR**  
**SHASHI SINHA**



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## CYTOTAXONOMIC CONSIDERATION OF *CHARA SOCOTRENSIS F. NUDA* (PAL) R.D.W. FROM MAHARASHTRA, INDIA.

M. V. INGAWALE, V.C.KARANDE\* AND C.T.KARANDE\*\*

### ABSTRACT

Present paper deals with taxonomic and cytological account of *Chara socotrensis f. nuda* (Pal) R.D.W. collected from western parts of Maharashtra. This is the first report of chromosome number of the species and the first record of the species from Satara District. Chromosome number of the species being reported is,  $n = 14$ . Comparison between the specimens found in other parts of country is also made in this account.

**Keywords :** *Chara, nuda*, chromosomes, morphology.

### Introduction

Charophytes are the macroscopic algal forms drawing extensive attention of phycologist now-a-days the world over. Work on cytology of Indian charophyta was initiated during the early part of 20<sup>th</sup> century when the reports on charophytes from the Northern and Southern parts were being made. (Sunderlingam 1946, Khan and Sarma 1967, Bhatnagar 1988, Chatterjee 1976, Ramjee and Sarma 1971, Sarma 1984, Sinha and Sinha 1992, Verma 1988, Gonzalvis 1963, Vaidya 1967, Bharathi and Chennaveeraiah 1980). However, the central part of the Indian subcontinent was being surveyed for morphology of these macrophytes by Dixit (1931, 1935, 1940a, 1940b, 1942), Vaidya (1967), Gonzalves (1963), Bharati and Chennaveeraiah (1980) and Kamat (1965). During last two decades some attention was being paid to these macrophyte from the Maharashtra by Jawlae (1986), Patil and Chaugule (1992), Karande and Chaugule (1999).

Survey on literature of charophytes from southern parts specially used the information of taxonomy and developmental studies. In order to update knowledge of taxonomy and cytology of the charophytes from Maharashtra this attempt has been made. During our survey numerous species of charophytes have been recorded. Of these, special attention is being paid to the ecorticate, monoecious species viz. *Chara socotrensis f. pashanii*, *C. socotrensis f. nuda*, *C. coralline* and *C. braunii*. Present investigation is the second record of *Chara nuda* from the area and its chromosome number is being

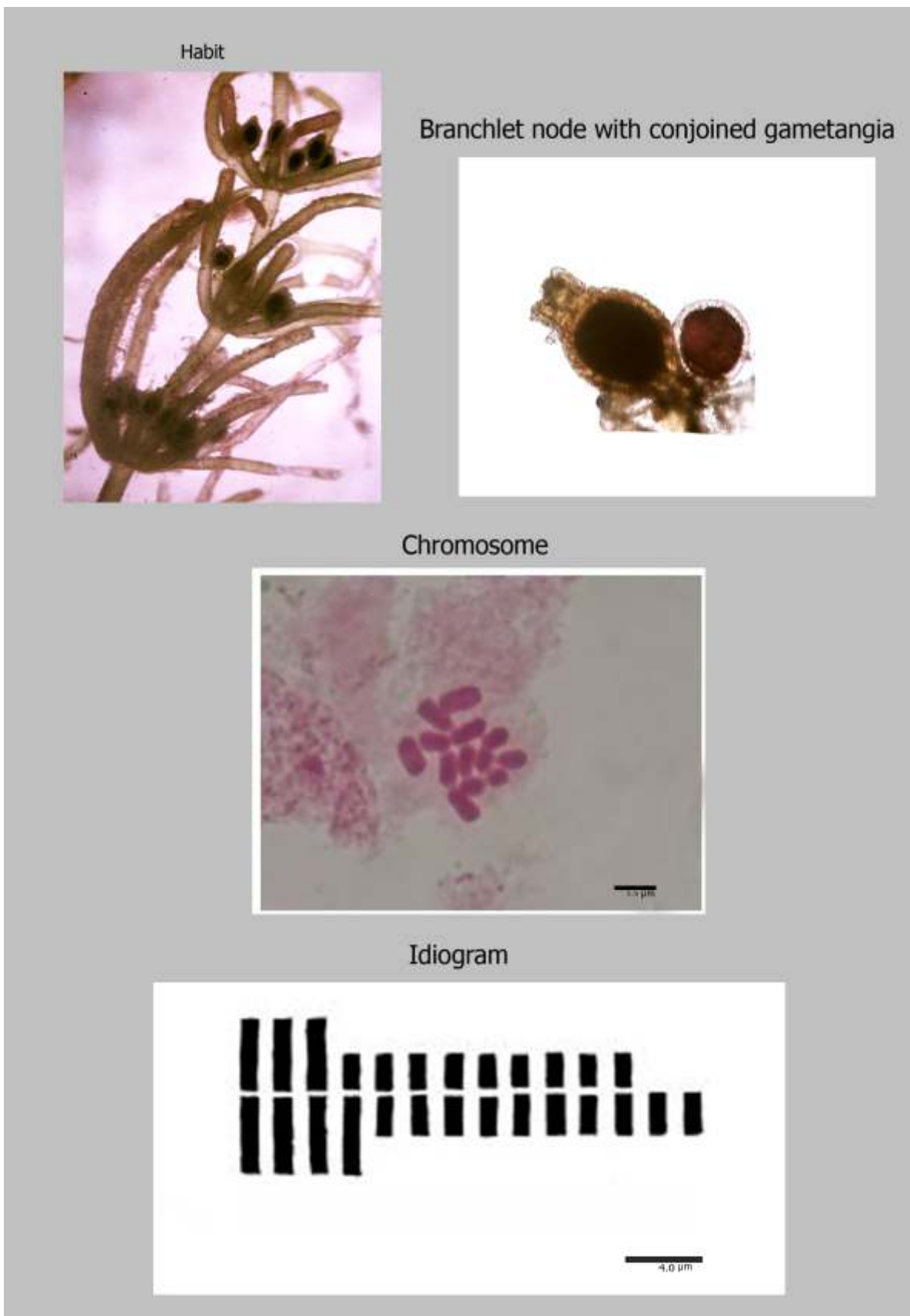
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**Plate 1.**



reported for the first time from this region.

### Material and methods

Plants were collected from the foothills of Sahyadri ranges around Satara, during July–Oct., 2007. Young growing fertile tips were washed thoroughly with tap water and were transferred to 8-hydroxyquinoline solution. After pretreatment tips were washed again with tap water to fix in Carnoy's acetic alcohol solution overnight and preserve in 70% alcohol for further cytological studies. Plants were also preserved in 4% formaldehyde solution for morphological observations. Identification was made using monographs by Wood and Imahori (1965), Zaneveld (1940) and Pal and Kundu (1960).

Squash preparation was made in 1% Acetocarmine (Godward 1948). Chromosome number was determined at metaphase. For karyotypic analysis methods devised by Levan *et al.* (1942) and Battaglia (1955) were employed. Camera lucida drawings and micro-photographs were taken from temporary preparations. Voucher specimens and slides have been deposited in the Department of Botany, Y. C. Institute of Science, Satara.

### Observations

Plants, monoecious, 3-12cm high, axes slender 293-410 $\mu$ m in diameter, internodes c 0.3-0.7cm long, cortex haplostichous, stipulodes rudimentary in one tier. Branchlet 7-9 in a whorl, 0.3-0.9cm 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 $\mu$ m long (excl.-coronula), 245-513 $\mu$ m wide, oogonia 513-777 $\mu$ m long (Incl.-coronula) and 250-513 $\mu$ m wide; convolutions 10-12; coronula 88-147 $\mu$ m high, 175-250 $\mu$ m wide. Oospores black, 513-586 $\mu$ m long, 293-498 $\mu$ m wide, striae-10 with prominent ridges, fossa 58-74 $\mu$ m. Antheridia 263-293 $\mu$ m in diameter. Chromosome number n=14.

Table 1. Measurements of chromosomes in *Chara socotrensis f. nuda*

No.	Length of chromosome arms ( $\mu$ m)		Total Length $\mu$ m	Centromeric Position	Type of chromosome
	Long arm	Short arm			
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 2. Classification of Chromosomes based on Battaglia.

Chromosome type	Number of Chromosome	Length in $\mu$ m	Karyotype formula A4 + B8 + C2 L(m <sub>3</sub> ,sm <sub>1</sub> ) + M(m <sub>8</sub> ) + S(t <sub>2</sub> )
A	4	5.8 - 4.4 $\mu$ m	
B	8	3.0 $\mu$ m	
C	2	1.5 $\mu$ m	



The chromosome number reported was  $n=14$ . Variation plates found, but rarely in the mitotic preparation with  $n=12$  and  $n=13$ . Out of fourteen chromosomes eleven chromosomes were metacentric, two telocentric and one was submetacentric (Table 2). The total complement showed four groups of chromosomes. Three of the 14 chromosomes measured  $5.8\ \mu\text{m}$ , one  $4.4\ \mu\text{m}$ , eight  $3.0\ \mu\text{m}$  while remaining two chromosomes were measured about  $1.5\ \mu\text{m}$ . Neither secondary constriction nor satellite portions were observed in the chromosomes (Refer to the ideogram).

## Results and discussion

*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 M. P.

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) observed the chromosome count of  $n=14$ . Chatterjee (1976) detected two cytotypes of this forma. One of these cytotypes showed  $n=28$  chromosomes and other showed  $n=14$ . 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 monoecious however, they differ morphologically from each other in many aspects. In forma *nuda* the stipulodes are rudimentary and alternate while they are absent in *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 (Table 3).

In prophase, the nucleus increased in size and numerous long intertwined chromatin threads were observed. Chromosomes arranged on metaphase plate were 14 in number and were highly condensed and rod shaped. A high degree of synchronization in antheridial filaments was observed throughout the length of filament. Based on length and centromeric position chromosomes were classified into three groups following Battaglia (1955).

A comparison between the Mecheda specimen and the present specimen showed correlation both in form and karyotype. The Mecheda specimen ( $n=28$ ) showed large size and presence of distinctly developed stipulodes while our specimen shows smaller and rudimentary stipulodes. The comparison between karyotype of two specimens showed that only half of the complement is represented in the Satara specimen i.e. 4 long, 8 medium and 2 short chromosomes were represented in Mecheda specimen. It indicates the lineage of the two specimens distributed to the distinct localities. Further investigations in this regard are needed.

## Acknowledgements

Authors are thankful to the Principal, Yashwantrao Chavan Institute of Science, Satara for encouragement and to the Head, Department of Botany, for providing laboratory facilities. MVI is grateful to the Head, Department of Botany, Kisan Veer Mahavidyalaya, Wai for constant encouragement.

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**Prof M N Noor**

**Prof M N Noor** was born on 10th January 1937 in Bihar (India); did M.Sc. degree in botany with specialization in Phycology from Ranchi University, Ranchi (1960); Ph.D. in Algal Cytology and Algal Cytogenetics under the guidance of Professor J. P. Sinha in (1966); did post-doctoral research on sequence of meiosis in Charophyta with Professor Mme. Michiline Guerlesquin in France during 1982-83 on a French Government Special Scholarship for a period of 8 months under Indo-French Exchange Programme; joined as an Assistant Professor in Botany, Ranchi University (1964), elevated to University Professor (1985) till 1997. Nearly a dozen candidates obtained their doctorate degrees under his supervision; visited Germany, Switzerland, England, Portugal and Spain; worked as a UGC Visiting Professor; recipient of Professor Y. S. R. K. Sarma Memorial Gold Medal by Society For Plant Research in 1999; Life Time Achievement Award -2014 by Krishnamurthy Institute of Algology, Chennai and Life Time Achievement Award -2015 by Society For Plant Research; around 75 publications to his credit in several International and National Journals of repute; authored a monograph on "Recent Trends in Charophyta Research" along with Professor S.K. Bhatnagar and Professor A. K. M. Nurul Islam, Dhaka University and also edited "Biology of Conjugales" with Professor Vidyavati, Warangal.



**Prof S K Bhatnagar**

**Prof S K Bhatnagar** was born on February 10, 1955, served the teaching profession since 1977 and retired as Professor & Dean, College of Biotechnology from S V P University of Agriculture & Technology, Meerut after 40 years of academic career. He also worked as Nodal Officer, College of Basic Science and Humanities. Prof Bhatnagar obtained Ph. D. degree in 1981, produced 16 Ph. D. and 10 M. Tech students, published more than 100 research papers in reputed journals and completed 9 research projects as PI and a NICHE Area project as Co-PI.. He established Society for Plant Research in 1988 as Founder Secretary General and started an International research journal VEGETOS since 1988.

Dr Bhatnagar published/edited 10 books and organized 11 national and 4 international conferences. He is Fellow of Linnean Society of London (FLS) and Indian Botanical Society (FBS) besides having INSA-COSTED, INDO-GREECE visiting scientist and VASVIK award to his credit. VASVIK Award -2010 was conferred by Prof R A Mashelkar, Former DG, CSIR in Mumbai. He worked as CPO and Director Placement in the present university. He is on the Expert panel of Uttarakhand Council of Biotechnology, CCRAS, Ministry of AYUSH, Government of India and Council of Scientific and Industrial Research for National Metallurgical Laboratory (NLM) beside being a Member/Member Co-Ordinator of National Assessment & Accreditation Council (NAAC). He accredited prestigious institutes like BARC, Tata Memorial Centre, Annamalai University, Gujarat Ayurveda University, Institute of Chemical Technology and many more. He is the Founder Director of HiQ Green Agroworld Pvt. Ltd., a company devoted for the High Quality Low Cost Technology.



**Dr Shashi Sinha**

**Dr Shashi Sinha** was born in the year 1953 in Patna. Childhood was spent in two geographically different place Patna, a plain and Ranchi a plateau. My father Late Professor (Dr.) Jwala Prasad Sinha, who had his university education in Banaras Hindu University and did his Ph.D from Landon University, gave us emotional and moral support to fight with the odds of life.

During his Post-Graduation in Botany Dr Sinha found Algal group of Plant quite interesting. Besides participation in International events dealing with fascinating group of algae, Dr Sinha visited several European (U.K, France) and Pacific countries including Japan and Australia. Dr Shashi was invited by the Government of Japan for Ramsar Convention in the year 1991. As Principal of College and Head of University Department of Botany, Dr Sinha served a long academic career.

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