



CHROMOSOMAL MORPHOMETRY AND KARYOTYPE OF *Suaeda maritima* (L.) Dumort. GROWING ALONG THE SOUTH-EAST COAST OF INDIA

Maniklal Pati¹ and Asis Kumar Nandi^{2*}

¹Department of Botany, Egra SSB College, Egra, Purba Medinipur - 721 429, West Bengal (India)

²Department of Botany & Forestry, Vidyasagar University, Medinipur - 721102, West Bengal (India)

*e-mail: aknind@mail.vidyasagar.ac.in; maniklalpati.1982@mail.com

(Received 23 May, 2024; accepted 29 August, 2024)

ABSTRACT

Suaeda maritima (L.) Dumort., an annual halophyte herb belonging to the family Chenopodiaceae, grows gregariously along the Southeast coast of India. This salt marsh species is regularly used by locals as food and for curing many diseases. Earlier works reported the presence of phenotypic plasticity and morpho-anatomical variations amongst the individuals of the species (Milic *et al.*, 2009). Cytological studies were undertaken to characterize the individuals of the species with respect to their karyotype. The diploid chromosome number of *S. maritima* was determined as $2n = 18$ from the root tips of species. The average length of metaphase chromosomes was $0.74 \pm 0.16 \mu\text{m}$ with total haploid chromosome length of $6.68 \pm 0.28 \mu\text{m}$. The average arm ratio was 1.13 ± 0.14 with average centromeric index of 0.46 ± 0.12 . All the 9 pairs of chromosomes were metacentric and out of 18 chromosomes 4 chromosomes contained NOR. The values of symmetry index (S%) and the degree of karyotype asymmetry was 51.51 ± 3.05 and 0.05 ± 0.01 , respectively. Intra-chromosomal asymmetry index and inter-chromosomal asymmetry index were 0.10 ± 0.02 and 0.22 ± 0.02 , respectively.

Keywords: Chromosome morphometry, karyotype, *Suaeda maritima*

INTRODUCTION

Suaeda maritima (L.) Dumort. is a species under genus *Suaeda* of family Amaranthaceae. The genus *Suaeda* includes 93 species (POWO, 2024), of which *S. maritima* grows luxuriantly in the eastern coast of southern part of India (Hossain *et al.*, 2022). This species is generally grown along the coastal belts of Indian subcontinent as well as other tropical and subtropical regions, between 25°N and 25°S latitude throughout the world and preferably in salt marshes of sea coast (Tomlinson, 1986). It is used as a vegetable (Pornpitakdamrong and Sudjaroen, 2014) and as ayurvedic medicine for curing different maladies in different parts of India and other countries (Trease *et al.*, 2002). The occurrence of this species on the south-east coast of India, especially in the coastal belt of Purba Medinipur district of West Bengal has previously been reported (Das *et al.*, 2015). The morphological and phytochemical accounts of individuals of the species growing along the coast of the Bay of Bengal in Purba Medinipur have been documented (Pati and Nandi, 2022a). The intra-specific genetic variation in *S. maritima* has been studied by using AFLP markers (Prinz *et al.*, 2009; Pati and Nandi, 2022b).

The chromosomal complements are of fixed nature represented by the karyotype for a taxon so any difference noted in the chromosomal complements denotes genetic diversity among them (Lim *et al.*, 2000; Mitthias and Elvira, 2016). Karyotypic analyses have immensely contributed to the understanding of phylogenetic relationship and divergence among the studied taxon (Weiss-

Schneeweiss and Schneeweiss, 2013). There are ample reports on the chromosomal characteristics of different species of *Suaeda* growing on different coasts of the World (Lomonosova *et al.*, 1993; Basset and Crompton, 2011; Zhang *et al.*, 2013). Cytological variations at the intraspecific level in genus *Suaeda* have earlier been reported (Jena *et al.*, 2002; Ronny *et al.*, 2015). Even different chromosomal numbers (2n) in several *Suaeda* species have been reported as 18, 36, 54, and 72 with consensual basic X = 9 (Mehra and Malik, 1963; Ebrahimzadeh *et al.*, 1994). Lomonosova *et al.* (2003) and Rice *et al.* (2015) have reported the karyomorphological features of *S. maritima* from different parts of the world; however, there is no report on the same about *S. maritima* growing along the coast of Bay of Bengal and South-east coast of India. Any deviation from the earlier reports may be inflicted on the ecological variation of growing sites of the individuals; especially as the individuals studied here are growing on a dynamic zone of coastal area. The present work undertook karyotypic analyses of *S. maritima* individuals from the south-east coast of India to scrutinize their detailed chromosomal features.

MATERIALS AND METHODS

The present study was conducted during the year 2022-2023. The root tips from germinated seeds were used for cytological studies and karyotypic analysis. The seeds of *Suaeda maritima* were collected from the individual plants of this species growing in the coastal area of Purba Medinipur district of West Bengal on the south-east coast of India which is located in between 21°63'16"N to 21°70'50"N latitude and 87°54'63"E to 88°12'40"E longitude. The study was conducted by sowing 20 seeds in 3 replicated trials in 1:1 soil and sea-shore sand in pots at normal temperature (around 35°C). Five root tips from each replica were taken to study the chromosome morphology. Root tips were pre-treated with para-di-chlorobenzene for 6 h at 15°C, fixed with 1:3 aceto-alcohol for 1 h and stained with 2% aceto-orcein for 2-3 h. The stained root tips were squashed in 45% acetic acid and observed under Leica Dm1000 microscope (x1800 magnification). Metaphase plates with well-scattered chromosomes were selected for chromosomal analyses.

For karyotypic analysis, the measurements of arm ratio (AR), total length of chromosome of haploid complements (HCL), relative length of chromosome (RL%) and centromeric index (CI) were worked out as per Levan *et al.* (1964). For karyotype asymmetry analysis both at intra- and inter-chromosomal level symmetry index (S%), the intra-chromosomal asymmetry index (A1), inter-chromosomal asymmetry index (A2) and degree of karyotype asymmetry (A) were measured (Martin *et al.*, 2018).

The images of metaphase plates taken from the microscopic observation were imported to IdeoKar software (Mirzaghaderi and Marzangi, 2015) for chromosomal measurements and generating the ideograms.

RESULTS AND DISCUSSION

The karyotype of *S. maritima* was prepared with the specimens collected from the coastal areas of West Bengal (India). The chromosome number (2n) of species was found to be 18 (Fig. 1). Ideogram of the karyotype is presented in Fig. 2. The average length of metaphase chromosomes was found to be $0.74 \pm 0.16 \mu\text{m}$ with individual length varying from 0.5 ± 0.02 to $0.99 \pm 0.02 \mu\text{m}$. The arm ratio ranged from 1.04 ± 0.08 to $1.50 \pm 0.06 \mu\text{m}$ with average mean of $1.13 \pm 0.14 \mu\text{m}$. The average centromeric index was 0.46 ± 0.12 with a range from 0.40 ± 0.06 to 0.48 ± 0.06 . All 9 pairs of chromosomes were recorded as metacentric (m) and 2 pairs of chromosomes contained nuclear organizer region (NOR) in the individuals of the region (Table 1).

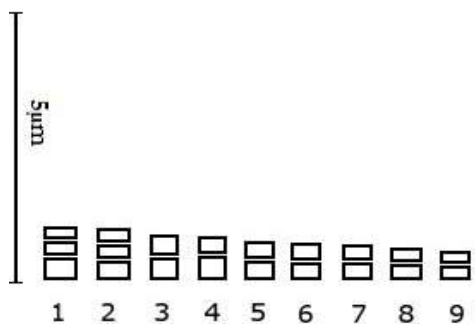


Fig. 1: Metaphase plate of *S. maritima* showing 18 chromosomes

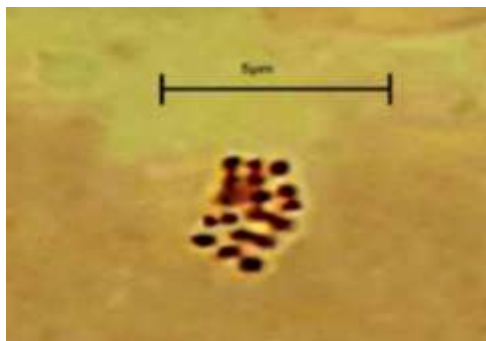


Fig. 2: Ideogram of metaphase chromosomes of *S. maritima* (graphical representation of 9 pairs of chromosomes with their respective primary constriction and secondary constriction).

The total length of chromosome of haploid complement (HCL) of 9 chromosomes was $6.68 \pm 0.28 \mu\text{m}$ in the individuals of the studied area (Table 2). The mean values of symmetry index (S%) and degree of karyotype asymmetry (A) were 51.51 ± 3.05 and 0.05 ± 0.01 , respectively, and the intra-chromosomal asymmetry index (A1) and inter-chromosomal asymmetry index (A2) were 0.01 ± 0.02 and 0.22 ± 0.02 , respectively (Table 2). The record of 18 chromosomes as a diploid complement for the individuals of the species studied in the area complies with the basic number (x) 9 as evident in other members of the family Chenopodiaceae (Shepherd and Yan, 2003; Ghaffari *et al.*, 2006) and the other species of genus Suaeda (Jena and Das, 2006; Ronny *et al.*, 2015). The preponderance of metacentric chromosomes in *S. maritima*, observed in the present study is quite consistent with the previous reports (Ebrahimzadeh *et al.*, 1994; Rice *et al.*, 2015; Cheng *et al.*, 2019).

The chromosomal length ranged from 0.5 ± 0.02 to $0.99 \pm 0.02 \mu\text{m}$ and the total chromosomal length of haploid set of $6.68 \pm 0.28 \mu\text{m}$ were quite corroborating with the plants of the same species growing in different coasts of Azerbaijan and Tehran (Ebrahimzadeh *et al.*, 1994). As suggested by Peruzzi and Eroglu (2013), the karyotype of *S. maritima* in consideration of the values of symmetry index (S%), the degree of karyotype asymmetry (A), intra-chromosomal asymmetry index (A1) showed higher symmetry (Table 2). The lower value of the inter-chromosomal asymmetry index (A2)

indicated less heterogeneity in chromosome length of the studied individuals of *S. maritima* (Table 2). Due to the extremely tiny size of all chromosomes, any minimum variation among these may remain imperceptible, but the striking consanguinity in some feature like the whole length of all chromosomes, the metacentric nature of all chromosomes and quite a smaller number of diploid

Table 1: Chromosome morphometry of *S. maritima* ($2n = 18$)

Chromosome	L (μm)	S (μm)	CL (μm)	AR	RL%	CI	Chromosome type	NOR
1	0.51 ± 0.02	0.48 ± 0.04	0.99 ± 0.02	1.06 ± 0.1	14.93 ± 1.2	0.48 ± 0.06	M	Present
2	0.54 ± 0.01	0.36 ± 0.04	0.90 ± 0.06	1.50 ± 0.08	13.57 ± 1.0	0.40 ± 0.06	M	Present
3	0.30 ± 0.02	0.27 ± 0.01	0.57 ± 0.08	1.11 ± 0.1	8.59 ± 1.0	0.47 ± 0.02	M	Absent
4	0.33 ± 0.02	0.30 ± 0.02	0.63 ± 0.06	1.10 ± 0.08	9.50 ± 1.2	0.47 ± 0.02	M	Absent
5	0.34 ± 0.04	0.32 ± 0.02	0.66 ± 0.02	1.05 ± 0.06	9.95 ± 1.2	0.48 ± 0.04	M	Absent
6	0.43 ± 0.02	0.41 ± 0.06	0.84 ± 0.06	1.04 ± 0.06	12.66 ± 1.6	0.48 ± 0.04	M	Absent
7	0.45 ± 0.04	0.39 ± 0.04	0.84 ± 0.06	1.15 ± 0.1	12.66 ± 1.2	0.46 ± 0.06	M	Absent
8	0.27 ± 0.01	0.24 ± 0.01	0.51 ± 0.02	1.12 ± 0.08	7.69 ± 1.0	0.47 ± 0.02	M	Absent
9	0.36 ± 0.02	0.33 ± 0.02	0.69 ± 0.04	1.09 ± 0.1	10.40 ± 1.2	0.47 ± 0.06	M	Absent
Mean	0.39 ± 0.09	0.34 ± 0.07	0.74 ± 0.16	1.13 ± 0.14	11.10 ± 2.44	0.46 ± 0.12	M	Absent

L - Length of long arm; S - Length of short arm; CL - Chromosome length; AR - Arm ratio; RL% - Relative length of chromosome; CI - Centromeric index; NOR - Nuclear organizer region

Table 2: Mean asymmetry analyses of karyotype of *S. maritima*

HCL (μm)	S%	A	A1	A2
6.68 ± 0.28	51.51 ± 3.05	0.05 ± 0.01	0.10 ± 0.02	0.22 ± 0.02

HCL - Total length of chromosome of haploid complements; S% - Inter-chromosomal level symmetry index; A1 - Intra-chromosomal asymmetry index; A2 - Inter-chromosomal asymmetry index; A - Degree of karyotype asymmetry

chromosomes complements, point towards the possible evolutionary changes occurred in them to cope up with the stress imposed by the hostile ecological environment of the area. The small size of individual chromosomes and quite a small number of diploid complements both help faster completion of DNA replication and cell division, the two most vital factors facilitating the propagation of a species in an uncongenial environment.

Acknowledgements: The authors are grateful to the Director of Central National Herbarium, Howrah, India for the identification and authentication of the species and special thanks the local people for their kind cooperation during sample collection.

REFERENCES

- Bassett, I.J. and Crompton, C.W. 2011. The genus *Chenopodium* in Canada. *Canadian Journal of Botany*, **60**: 586-610.
- Cheng, Y., Yang, P., Zhao, L., Priyadarshani, S.V.G.N., Zhou, Q., Li, Z., Li, W. and Qin Y. 2019. Studies on genome size estimation, chromosome number, gametophyte development and plant morphology of salt tolerant halophyte *Suaeda salsa*. *BMC Plant Biology*, **19**: 473. [<https://doi.org/10.1186/s12870-019-2080-8>].
- Das, D.C., Pati, M. and Mahato, G. 2015. Study of the tidal vegetation of Purba Medinipur district of West Bengal, India. *International Journal of Bioassays*, **4**(5): 3915-3921.
- Ebrahimzadeh, H., Ataei-Azimi, A., Akhiani, H. and Noori-Dalooi, M.R. 1994. Studies on the caryology of some species of the genus *Suaeda* (Chenopodiaceae) in Iran. *Journal of Sciences, Islamic Republic of Iran*, **5**(3): 81- 88.
- Ghaffari, S.M., Saydrasi, L., Ebrahimzadeh, H. and Akhiani, H. 2006. Chromosome numbers and karyotype analyses of species of subfamily Salicornioideae (Chenopodiaceae) from Iran. *Iranian Journal of Botany*, **12**(2): 128-135.
- Hossain, S.K.A., Mondal, I., Thakur, S. and Ayad, M.F. 2022. Coastal vulnerability assessment of India's Purba Medinipur-Balasore coastal stretch: A comparative study using empirical models. *International Journal of Disaster Risk Reduction*, **77**: 103065. [<https://doi.org/10.1016/j.ijdr.2022.103065>].
- Jena, S., Sahoo, P., Mohanty, S., Das, A.B. and Das, P. 2002. Karyotype variation and cytophotometric estimation of in situ DNA content in some minor and associate mangroves of India. *Cytologia*, **67**: 15-24.
- Jena, S.N. and Das, A.B. 2006. Inter-population variation of chromosome and RAPD markers of *Suaeda nudiflora* (Willd.) Moq. a mangrove species in India. *African Journal of Agricultural Research*, **1**(4): 137-142.
- Levan, A., Fredga, K. and Sandberg, A.A. 1964. Nomenclature for centromeric position on chromosomes. *Hereditas*, **52**: 201-220.
- Lim, K.Y., Matyasek, R., Lichtenstein, C.P. and Leitch, A.R. 2000. Molecular cytogenetic analyses and phylogenetic studies in the *Nicotiana* section *Tomentosae*. *Chromosoma*, **109**: 245-258.
- Lomonosova, M.N. and Krasnikov, A.A. 1993. Chromosome numbers in some members of the Chenopodiaceae. *Botanicheskii Zhurnal*, **78**(3): 158-159 (in Russian).

- Lomonosova, M.N., Krasnikov, A.A. and Krasnikova, S.A. 2003. Chromosome numbers of Chenopodiaceae family members of the Kazakhstan flora. *Botanicheskii Zhurnal*, **88**(2): 134-135.
- Martin, E., Yildiz, H.K., Kahraman, A., Binzat, O.K. and Eroglu, H.E. 2018. Detailed chromosome measurements and karyotype asymmetry of some *Vicia* (Fabaceae) taxa from Turkey. *Caryologia*, **71**(3): 224-232.
- Matthias, B. and Elvira, H. 2016. Karyotype evolution supports the molecular phylogeny in the genus *Ranunculus* (Ranunculaceae). *Perspectives in Plant Ecology, Evolution and Systematics*, **18**: 1-14.
- Mehra, P.N. and Malik, C.P. 1963. Cytology of some Indian Chenopodiaceae. *Caryologia*, **16**: 67-84.
- Milic, D., Lukovic, J., Zoric, L. and Boza, P. 2009. Morpho-anatomical differentiation of *Suaeda maritima* (L.) Dumort. (Chenopodiaceae) populations from inland and maritime saline area. *Central European Journal of Biology*, **4**(1):117-129.
- Mirzaghaderi, G., Karim, M.K. 2015. IdeoKar: An ideogram constructing and karyotype analysing software. *Caryologia*, **68**(1): 31-35.
- Pati, M. and Nandi, A.K. 2022a. Morphological and phytochemical studies of *Suaeda maritima* (L.) Dumort. growing along the coastal belt of Purba Medinipur district, West Bengal, India in search of the prospective variation. *Current Botany*, **13**: 34-39.
- Pati, M. and Nandi A.K. 2022b. Genetic relationship between populations of *Suaeda maritima* (L.) Dumort. growing along the Coastal belt of Purba Medinipur district, West Bengal, India in respect of AFLP performance. *Research Journal of Agricultural Sciences*, **13**(6): 1741-1745.
- Pornpitakdamrong, A. and Sudjaroen, Y. 2014. Seablite (*Suaeda maritima*) product for cooking, Samut Songkram province, Thailand. *Food and Nutrition Sciences*, **5**: 850-856.
- POWO. 2024. *Plants of the World Online*. The Royal Botanic Gardens, Kew. Surrey, England [<https://powo.science.kew.org/>].
- Prinz, K., Weising, K. and Hensen, I. 2009. Genetic structure of coastal and inland populations of the annual halophyte *Suaeda maritima* (L.) Dumort. in Central Europe, inferred from amplified fragment length polymorphism markers. *Plant Biology*, **11**: 812-820.
- Rice, A., Glick, L., Abadi, S., Einhorn, M., Kopelman, N.M., Minkov, A.S, Mayzel, J., Chay, O. and Mayrose, I. 2015. The chromosome counts database (CCDB) a community resource of plant chromosome numbers. *New Phytologist*, **206**: 19-26.
- Ronny, B., Maria, L., Kurt, W., Natascha, W. and Helmut, F. 2015. Phylogeny and biogeography of *Suaeda* subg. *Brezia* (Chenopodiaceae/Amaranthaceae) in the Americas. *Plant Systematics and Evolution*, **301**: 2351-2375.
- Shepherd, K.A. and Yan, G. 2003. Chromosome number and size variation in the Australian Salicornioideae (Chenopodiaceae) - Evidence of polyploidization. *Australian Journal of Botany*, **51**: 441-452.
- Trease and Evans. 2002. *Pharmacognosy*. University of Nottingham, Nottingham, UK.
- Weiss-Schneeweiss, H., Villasenor, J.L. and Stuessy, T.F. 2009. Chromosome numbers, karyotypes and evolution in *Melampodium* (Asteraceae). *International Journal of Plant Sciences*, **170**: 1168-1182.
- Zhang, F. and Yao, Y. 2013. Karyotype analysis of *Suaeda salsa* (L) Pall. *Shandong Science*, **26**: 53-55.