Cytotaxonomical Studies in Indian *Urginea* Steinhill Species

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The genus *Urginea* Steinhill (Liliaceae) is represented in India by about nine species (Hooker 1892, Blatter and McCann 1928, Boraiah and Fatima 1970, 1982, Ansari 1981, Hemadri and Swahari 1982). A taxonomic revision of the genus has been made by Deb and Dasgupta (1974, 1981, 1987) and reduced to five species. A survey of literature indicated that *U. indica* and *U. polyantha* are the only taxa studied cytologically while remainings are unexplored from the cytotaxonomic point of view. The present investigation, therefore, reports the comparative karyomorphological analysis in four species of *Urginea*, viz. *U. congesta* Wight, *U. razii* (Ansari) Deb et Dasgupta, *U. polyantha* Blatter and McCann and *U. indica* Kunth. It is of particular interest to note that a species *U. polyphylla* Hook. has not been included in present studies because in spite of extensive field trips, authors could not locate it. Its exact natural origin is badly documented, its collector is known to be Heyne (Hooker 1892). After Heyne, there is no report of its occurrence and therefore its presence seems to be doubtful. However, this problem cannot be settled on the basis of the available herbarium specimens alone, relocation of this species in its natural habit is still urgently required.

Materials and methods

Materials for the present studies were collected from peninsular India. The collected samples (minimum 100 bulbs of each) were grown in the experimental gardens of Botany Department under uniform conditions. The morphological features of the taxa under investigation were critically assessed from fresh materials and voucher specimens have been deposited in the herbarium of the department.

Materials and methods adopted for the karyotype analysis and meiotic studies are the same as reported earlier (Dixit and Yadav 1989). Karyotype symmetry has been analysed using Stebbins' (1958) system of classification based on relative arm-lengths and arm-ratios. F% and TF% were calculated as given by Huziwara 1962, while relative length (TCL%) and S% by applying following formulae:

$$\text{Relative length (TCL \%)} = \frac{\text{Chromosome length}}{\text{Absolute length}} \times 100$$

$$\text{Relative length of shortest chromosome (S \%)} = \frac{\text{Length of shortest chromosome}}{\text{Length of largest chromosome}} \times 100$$

Observations

General morphological characters of *Urginea* species under study are tabulated in Table 1, and are showed in Figs. 1–5, and graphically represented in Fig. 6.

All the species of *Urginea* under investigation are diploids and showing 20 chromosomes in their somatic complements except *U. indica* where B chromosomes are observed (Figs. 7–11). Chromosomes are in general long with subtelocentric centromeres in all the taxa.

Figs. 1-5. 1, species of *Urginea* in vegetative phase. 2, species of *Urginea* in reproductive phase. 3, entire fruits of *Urginea* species. 4, seeds of *Urginea* species. 5, pollen grains of *Urginea* species; ($\times 510$.) UC: *U. congesta*, UR: *U. razii*, UP: *U. polyantha* and UI: *U. indica*.

With a view to describe the karyotype following categorisation of chromosomes has been made:

b) *Urginea congesta*

c) *U. razi*

d) *U. polyantha*

e) *U. indica*

Fig. 6. Polygraphs of *Urginea* species.

Figs. 7-16. 7, mitotic chromosomes of *U. congesta* showing $2n=20$, $\times 1790$. 8, mitotic chromosomes of *U. razii* showing $2n=20$, $\times 1790$. 9, mitotic chromosomes of *U. polyantha* showing $2n=20$, $\times 1790$. 10, mitotic chromosomes of *U. indica* showing $2n=20+3B$, $\times 1790$. 11, mitotic chromosomes of *U. indica* showing $2n=20+3B$, $\times 1790$. 12, idiograms of *Urginea* species: *U. congesta*, *U. razii*, *U. polyantha* and *U. indica*. 13, diakinesis of *U. congesta* showing 10 bivalents, $\times 930$. 14, diakinesis of *U. razii* showing 10 bivalents, $\times 930$. 15, diakinesis of *U. polyantha* showing 10 bivalents, $\times 930$. 16, diakinesis of *U. indica* showing 10 bivalents, $\times 930$.

Type A: Longest chromosomes (8.06–7.03 μm) with constriction in subtelocentric (st) region.

Type B: Long chromosomes (5.88–6.89 μm) with constriction in subtelocentric (st) region.

Type C: Medium long chromosomes (4.04–5.57 μm) with constriction in subtelocentric (st) region.

Type D: Medium chromosomes (3.02–3.82 μm) with constriction in subtelocentric (st) region.

Type E: Short chromosomes (2.61–2.98 μm) with constriction in subtelocentric (st) region.

Details of somatic chromosomes and karyotypic parameters of *Urginea* species are depicted in Table 2 and idiogrammed in Fig. 12.

The meiosis was found normal in all the taxa under study with 10 bivalents at diakinesis (Figs. 13–16). Later stages were also found normal with 92–98% pollen fertility.

Table 1. Comparative account of morphotaxonomical characters of Indian species of *Urginea*

Characters/species	<i>U. congesta</i>	<i>U. razii</i>	<i>U. polyantha</i>	<i>U. indica</i>
Geographical distribution	Inland (Interior area)	Inland (Interior area)	Inland (Interior area)	Coastal regions of the country
Length of plant (cm)	25.6 $\pm$ 5.3	21.8 $\pm$ 4.9	26.3 $\pm$ 6.7	37.3 $\pm$ 8.4
Diameter of bulb (cm)	3.8 $\pm$ 1.4	3.2 $\pm$ 0.9	3.9 $\pm$ 0.85	4.6 $\pm$ 0.95
Number of leaves per plant	3.0 $\pm$ 0.4	5.0 $\pm$ 1.5	6.0 $\pm$ 2.0	9.0 $\pm$ 3.5
Size of leaf (L $\times$ B) (cm)	20.5 $\pm$ 5.2 $\times$ 1.03 $\pm$ 0.35	15.8 $\pm$ 4.9 $\times$ 0.32 $\pm$ 0.9	20.11 $\pm$ 5.6 $\times$ 1.4 $\pm$ 0.6	26.9 $\pm$ 7.5 $\times$ 3.1 $\pm$ 0.5
Height of inflorescence (cm)	6.4 $\pm$ 1.02	15.7 $\pm$ 3.3	29.6 $\pm$ 8.2	95.5 $\pm$ 8.3
Basal diameter of scape (cm)	2.3 $\pm$ 0.4	1.64 $\pm$ 0.3	2.8 $\pm$ 0.5	3.9 $\pm$ 0.1
Pedicle length (cm)	0.4 $\pm$ 0.2	0.6 $\pm$ 0.2	0.8 $\pm$ 0.1	3.7 $\pm$ 0.8
Diameter of flower (cm)	1.6 $\pm$ 0.3	1.5 $\pm$ 0.2	1.4 $\pm$ 0.1	2.1 $\pm$ 0.3
Blooming period	Day-blooming	Day-blooming	Day-blooming	Night-blooming
Anthesis time	10 a. m.	10 a. m.	4 p. m. (previous day of blooming)	4 p. m.
Length of stamen (mm)	5.2 $\pm$ 0.8	5.2 $\pm$ 0.4	4.2 $\pm$ 0.5	7.7 $\pm$ 0.9
Length of gynoecium (mm)	6.7 $\pm$ 0.7	6.09 $\pm$ 0.49	5.07 $\pm$ 0.42	8.86 $\pm$ 0.87
Ovules per ovary	25.5 $\pm$ 3.3	20.6 $\pm$ 2.31	26.4 $\pm$ 3.78	52.5 $\pm$ 7.9
Fruit size (L $\times$ B) (cm ²)	7.41	3.82	5.97	11.46
Seeds per ovary	12.6 $\pm$ 4.6	9.08 $\pm$ 4.46	14.6 $\pm$ 5.91	23.5 $\pm$ 6.1
Seed output per plant	89.3	54.5	212	145.6
Seed index (L $\times$ B) (mm ²)	48.5	21.83	23.36	35.15
Pollen size (L $\times$ B) (μm)	65 $\times$ 62	73 $\times$ 69	68 $\times$ 64	80 $\times$ 78
Pollen wall ornamentation	Fine reticulate	Fine reticulate	Reticulate	Coarse Reticulate
Chromosome number (2n)	20	20	20	20, 20+3B

Discussion

Indian squill, *U. indica* has extensively been studied cytologically (Raghavan 1935, Naik 1976, Sen 1974, Subramanian 1978, Zha and Sen 1983 a, b) and revealed the presence of polyploid, aneuploid series though diploid with $2n=20$ chromosomes is most common. It is evident from the present investigation that except in *U. indica* all species of *Urginea* show $2n=20$ and $n=10$ (Figs. 7–11 and 13–16). Thus the first record of chromosome number has been made in *U. congesta*, *U. razii* and haploid number in *U. polyantha*, while confirmation of earlier reports of chromosome number made in *U. indica* and *U. polyantha*.

It is apparent from the present study that all the species represent 'sharp specific differentiations' (Table 1, Figs. 1–6) and asymmetrical karyotype with subterminal primary constrictions in all chromosomes (Table 2, Figs. 7–12). The karyotypes reported for the

genus all seem to include 2 pairs of long chromosomes, while remaining 8 pairs are more or less gradually decreasing in size from medium to small (Fernandes and Neves 1962, Oyewole 1987). Exception for this is *U. altissima* where 3 submetacentric chromosomes are reported by Nwankiti (1983).

The genus, *Urginea*, as a whole is well characterised on the basis of morphology and chromosome structure. However, at lower taxonomic levels the few and ill defined morphological traits and considerable degree of genetic and modificational plasticity have prevented a satisfactory systematic differentiation, until recently in *U. indica*. In this context detailed karyotypic analysis of the present study is helpful to ascertain the differences between species at chromosomal level. It is revealed from the Table 2 that karyotypic pattern differs from species to species and thus confer clear species status to the taxa under study.

Differences in absolute chromosome size reflects different amounts of gene duplications either in tandom fashion or through polytene multiplication of chromonemata and also that the species having greater chromatin length were supposed to be primitive whereas species with lesser chromatin length were treated as advanced (Stebbins 1971). It is thus clear from

Table 2. Details of chromosome number and karyotypic parameters in *Urginea* species

Species	2n	n	Total chromosomal length (μ m) of haploid set with range $\pm$ S. E.	Karyotypic formula	Range of F%	TF%	Range of TCL%	S%	Karyotype symmetry (Stebbins notation)
<i>U. congesta</i>	20	10	46.68 (8.06–3.11) ($\pm 1.57 \pm 0.57$)	4A st + 6C st + 10D st	14.38 –19.72	16.49	6.66 –17.26	38.58	2b
<i>U. razii</i>	20	10	42.52 (7.51–2.75) ($\pm 1.61 \pm 0.47$)	2A st + 2B st + 4C st + 8D st + 4E st	16.74 –23.29	18.84	6.46 –17.66	42.24	2b
<i>U. polyantha</i>	20	10	40.72 (7.06–2.01) ($\pm 1.13 \pm 0.30$)	2A st + 2B st + 4C st + 6D st + 6E st	16.43 –22.99	19.20	6.40 –17.33	36.97	2b
<i>U. indica</i>	20	10	43.33 (7.55–2.73) ($\pm 1.06 \pm 0.39$)	2A st + 2B st + 4C st + 10D st + 2E st	13.90 –23.44	17.36	6.30 –17.42	36.15	2b

the present investigation (Table 2) that amongst 4 species of *Urginea*, *U. polyantha* is most advanced to others. Wider range of F%, lower TF% and S% indicating that specialization of karyotype has taken place in *U. polyantha* followed by *U. indica*, *U. razii* and *U. congesta*. However, close homology is apparent in *U. indica*, *U. polyantha* and *U. razii* while distant relationship with *U. congesta*. The earlier reports on hybridization also supports this view strongly (Dixit and Yadav 1989).

In spite of the same chromosome number in all the 4 species of *Urginea* under study, the alteration in karyotype formulae (Table 2) at interspecific level is a clear index of the role of structural alterations in evolution of species in this genus. It is also interesting to note that the time of flower opening and closing is peculiar and must have played an important role in speciation. The flowers of *U. congesta*, *U. razii* and *U. polyantha* remain open in day time while those of *U. indica* open during evening hours and close by morning. Thus reproductive isolation through differences in time of blooming of flowers seems to be one of the important factors in speciation of genus *Urginea*. However, ecogeographical mechanism may be operating in separating them. The wide-spread distribution of *U. indica* and other species of *Urginea* in

India leads one to think that the India may be at least a secondary centre of variation for this genus in particular and family in general.

Summary

Karyotypic analysis of 4 species of *Urginea* Steinh. from India has been made. All the taxa under study are diploids and showing $2n=20$ and $n=10$ except *U. indica* where $2n=20+3B$ is also observed. Asymmetrical karyotype with all subtelocteric chromosomes was found as a characteristic of this genus. It has revealed from the present study that there are sharp specific differences at species level. However, close homology in *U. indica*, *U. polyantha* and *U. razii* while distant relationship of these taxa with *U. congesta* is confirmed. Speciation through structural alterations at chromosomal level and reproductive isolation through differences in time of flower blooming is discussed. Wide distribution and variation in *U. indica* and other species of *Urginea* in India is considered to be a result of evolution in secondary centre of variation.

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