Cytology of Species of Hemerocallideae from South India

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The Hemerocallideae (*sensu* Hutchinson 1973) is a small tribe with four genera such as *Hosta*, *Hemerocallis*, *Leucocrinum* and *Hesperocallis* of mostly East Asian and American distribution. Concerning the composition and systematic relationships of the tribe there is much controversy in the different classifications of the monocots. Species of *Hosta* and *Hemerocallis* are grown here as introduced garden plants. Cytology of two species of *Hosta* and one of *Hemerocallis* is reported here.

Materials and methods

Materials of species of *Hosta* (*H. lancifolia* Spring, and *H. ovata* Spring) and *Hemerocallis* (*H. fulva* L.) were procured from high altitude gardens in Ootacamund and Kodaikanal. Chromosomes were studied from PMCs and/or root tip cells. Flower buds and root tips were fixed in 3:1 Carnoy's fluid, and chromosome preparations made by acetocarmine smear and squash techniques. Root tips were pretreated in 0.002 M solution of 8-hydroxyquinoline at 4°C for 2 hrs. Karyotype analysis was made following Levan *et al.* 1964, and karyotype asymmetry and TF% determined after Stebbins 1958 and Huziwara 1962 respectively.

Observations

Hosta lancifolia

Root tip cells showed 60 chromosomes (Fig. 1), and they exhibited striking size variation, ranging from 9.50 to 1.50 μm in length, and could be classified into three distinct size classes such as 4 pairs of very large sized, 1 pair of medium sized and 25 of very small chromosomes. The large and medium sized chromosomes were acrocentrics, and the centromere positions of the small chromosomes were indistinct. The karyotype was highly asymmetrical and specialised. The same chromosome number (Sato 1942, Sharma Chatterjee 1958) and also another number, $2n=40$ (Mookerjee 1956) were previously reported in the species.

H. ovata

Root tip cells showed $2n=120$ chromosomes (Fig. 2). Here also the chromosomes showed extreme size variation (7.00 to 1.00 μm), and the somatic complement consisted of 8 pairs of large, 2 medium sized and 50 of very small chromosomes. The large and medium sized chromosomes were acrocentrics. The karyotype was highly asymmetrical. Previously $2n=40$ was reported in the species (Mookerjee 1956).

Hemerocallis fulva

Materials of this species were studied from two localities in South India (Ootacamund and Kodaikanal). Both the materials showed the same chromosome number, $n=11$ and $2n=22$. During meiosis the bivalents showed high degree of association at diakinesis and

metaphase I. Fairly spread out bivalents were noticed only in a small proportion of PMCs (Fig. 3). Anaphase separation was irregular resulting in significant reduction in pollen fertility. Root tip cells in both the accessions showed the same chromosome number of $2n=22$

Figs. 1-6. Chromosomes of species of *Hosta* and *Hemerocallis*. All figs. $\times 1000$. 1, *Hosta lancifolia*, $2n=60$. 2, *H. ovata*, $2n=120$. 3, *Hemerocallis fulva*, PMC at diakinesis showing 11 bivalents. 4, *H. fulva*, PMC at metaphase I. 5, *H. fulva* (Ootacamund material), $2n=22$. 6, *H. fulva* (Kodaikanal material), $2n=22$.

(Figs. 5, 6). The chromosomes were fairly large sized, and ranged from 15.5 to $5.40 \mu\text{m}$ in length. In gross karyomorphology, both the accessions were almost similar and possessed 4 pairs of m-type (all small), 4 sm-type and 3 of st-type chromosomes, and the karyotype was graded and of medium asymmetry (3B) with a TF% of 36.50. Between the two accessions some

difference was noticed in total chromosome length and in the morphology of two pairs of chromosomes, namely chromosome no. 2 in the Ootacamund and no. 3 in the Kodaikanal material respectively which showed structural heteromorphism with respect to centromere position. Some of the previous workers have reported $2n=33$ (Hill 1978, Ferakova and Murin 1978, Pandita 1979) and $2n=36$ (Dutta and Bhattacharya 1981) in the species.

Discussion

Chromosome data on the tribe Hemerocallideae show that the four cytologically known genera have different basic chromosome constitutions, *Hosta* based on $x=10$, *Hemerocallis* $x=11$, *Leucocrinum* $x=7$ and *Hesperocallis* on $x=8$. From the angle of chromosome constitution they do not seem to be closely related. This dissimilarity is obvious between *Hosta* and *Hemerocallis*, both in terms of chromosome number and size and morphology of chromosomes. The chromosomes of species of *Hosta* show sharp size variation and they possess highly specialised karyotypes. The chromosomes of species of *Hemerocallis* on the other hand are large sized with very little size variation, and the karyotype graded and symmetrical. This appears to be suggestive that the two genera may not be of a common origin.

Species of *Hosta* constitute a polyploid series with $2n=40, 60, 90$ and 120 . Concerning the chromosome evolution in the genus, Maekawa and Kaneko 1968 have postulated that the present-day $2n=60$ species which possess 4 pairs of very long acrocentric, two medium sized sub-metacentric and 24 of very small chromosomes might have evolved from a prototype with 6 pairs of large median-constricted chromosomes comprising two components ($6+6$), of which one component (6 metacentrics) underwent reduction in size by progressive deletion of one of the arms to form st-type chromosomes. The chromosomes of the other component were influenced by the secondary establishment of new constrictions in their both arms followed by disappearance of the primary constriction which induced disjunction of the chromosomes into two, and multiplied their number at least two times in the same manner. Finally two chromosomes of the former component might have undergone further modification, chiefly reduction of one arm by deletion, thereby the karyotype eventually becoming $4L+2M+24S=30$. According to this contention the original basic chromosome number in *Hosta* must be 6. The kind of karyotype evolution in *Hosta* postulated by Maekawa and Kaneko looks highly speculative, and it should involve very unusual mechanisms of karyotype changes. It may be possible on the other hand to consider the original basic number of *Hosta* to be 10, and the present-day high chromosome numbered taxa ($2n=40, 60, 120$) with the type of karyotype features they exhibit, could have arisen by polyploidy on $x=10$ accompanied by large scale structural alterations, mostly involving differential deletion and elimination of chromosome arms of most of the chromosomes in the complement resulting in sharp intrakaryotypic chromosome size difference.

Hutchinson 1959 has included *Hosta* and *Hemerocallis* together in his tribe Hemerocallideae of the Liliaceae. But earlier systematists have treated *Hemerocallis* under the Amaryllidaceae (Bentham and Hooker 1883). The chromosomal difference between *Hosta* and *Hemerocallis* is very wide both in terms of number and karyomorphology. Cytologically *Hosta* appears to be very similar to the typical genera of the Agavaceae (*Agave-Yucca* type). Serologically also similarity has been suggested between *Hosta* and members of the Agavaceae (Chupov and Kutiavina 1981). However, the cytological and chemical similarity is not shared by exomorphic features. Dahlgren and Clifford 1982 have held that *Hosta* and Agavaceous genera have possibly developed by convergence, and they have placed their Funariaceae (which include *Hosta*) and Agavaceae separately and at some distance from each other in their Asparagales. Takhtajan 1980 has treated *Hosta* in his Agavaceae and suggested

relationship with his Hemerocallidaceae and Phormiaceae ascribing possible common origin for them. Chromosomally *Hemerocallis* resembles the *Amaryllis* type of the Amaryllidaceae, and their very comparable karyotype features apparently support Hutchinson's opinion that the Amaryllidaceae may have originated from the Hemerocallidaceae of the Liliaceae. Dahlgren *et al.* 1985 have placed *Hemerocallis* in a monotypic family Hemerocallidaceae. The present authors are very much inclined to support this view.

Summary

Cytology of two species of *Hosta* such as *H. lancifolia* ($2n=60$) and *H. ovata* ($2n=120$) and one of *Hemerocallis*, namely *H. fulva* ($2n=22$) is reported. The species of *Hosta* so far known constitute a polyploid series on $x=10$, while *Hemerocallis* is based on $x=11$ and diploid. The karyotypes of species of *Hosta* were highly asymmetrical with sharp intrakaryotypic chromosome size difference, and that of *Hemerocallis* graded and symmetrical with large sized chromosomes. It is contended that the high chromosome numbered taxa of *Hosta* may have arisen by polyploidy on $x=10$ accompanied by large scale chromosomal structural alterations, mostly involving differential deletion and elimination of chromosome arms of most of the chromosomes.

The disputed systematic relationships of *Hosta* and *Hemerocallis* are viewed in the light of chromosome data. Both in chromosome number and karyomorphology *Hosta* appears to be very similar to the Agavaceous genera, and *Hemerocallis* to *Amaryllis* type. The separation of *Hosta* and *Hemerocallis* from the common tribal fold and treatment of *Hemerocallis* in a separate monotypic family Hemerocallidaceae proposed by Dahlgren *et al.* appear to be cytologically justifiable.

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