Cytogeographical Studies on *Scilla indica* in India—Triploids

A. Sheriff and Usha Gopala Rao

Department of Botany, Bangalore University, Central College,
Bangalore 1, India

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Scilla is a genus of about 100 species of bulbous plants which are natives of Europe and extra-tropical regions of Asia and Africa. *Scilla indica* is widely distributed over central India, the Deccan Peninsula and Sri Lanka, and is highly polymorphic, populations exhibiting marked phenotypic variations in different geographical regions of the country often looking like different species. Reports on the chromosome number of this taxon in India are varying. Raghavan and Venkatasubban (1939) were the first to investigate the cytological aspects of *S. indica* which they had collected from the Madras area in India. In this, they described three distinct karyotypes with $2n=44, 45, 46$ chromosomes and considered them as three aneuploid races. Bhaduri (1944) confirmed the number as $2n=44$ in the material obtained from Raghavan. Sheriff and Murthy (1946) were the first to report $2n=30$ chromosomes in *S. indica* occurring in the Kolar Hills area in Karnataka State in south India. Sunder Rao (1953) reported $2n=58$ in *S. indica* collected from the Sagar area in Madhya Pradesh in central India and considered it as yet another chromosome race distinct from those studied by Raghavan and Venkatasubban. This rather confusing cytological picture of the taxon in the country prompted the author to subject this taxon to a detailed cytological survey on a regional and population-wise basis. The results were highly rewarding and provided a clear picture of the cytological set-up of this taxon in the country. A paper, the first in the series, dealt with the cytogeographical aspects of the taxon collected from different geographical regions of central and south India, all at the diploid level with $2n=30$ chromosomes and thus establishing the basic number of 15 for the taxon in the country (Sheriff 1975). The present paper, the second in the series, deals with the cytogeographical aspects of two unique populations of *S. indica* both of which represent well established triploids with $2n=45$, which are found confined and isolated in the Madras area and which were formerly mistaken to be aneuploid races.

Material and methods

Living plants were collected from two areas in Madras, the Adyar seaside area and the Saidapet Teachers College area. In both the places the plants were found growing wild. At Adyar, the plants (designated as Collection S-24) were found in great abundance and robust looking. Their leaves were relatively broad with large dark blotches on their surface, a few of the leaves bearing bulbils at their tips

(Fig. 3). A few plants here and there were found with small sickly looking inflorescences with pale flowers shrivelling up without producing any fruit. The Saidapet Scillas (designated S-25), unlike the Adyar Scillas, were fewer in number and narrow-leaved with small dark blotches, the tip of almost every leaf bearing a cluster of robust bulbils (Fig. 4). Both these collections grew luxuriently in the departmental garden at Bangalore, multiplying profusely through the leaf-tip bulbils. Unlike other Scillas (diploids) which do not last beyond late July or early August, the Adyar Scillas continued in their vegetative condition upto the end of September while the Saidapet Scillas continued even upto January when there was no trace of any *Scilla* either in the garden or in the wild.

Karyotype studies were made from acetic-orcein squashes of root tips pre-treated with colchicine. Acetic-carmines squashes of pollen mother cells were used for meiotic studies. For analysis and comparison of the karyotypes, the chromosomes were classified into four principal types—Type A (long chromosomes), Type B (medium chromosomes), Type B^s (medium chromosomes with satellites), and Type C (short chromosomes).

Observations

1. *Scilla indica* from Adyar area (S-24).

The karyotype in this consists of $2n=45$ chromosomes (Figs. 1 and 5) with the following karyotype formula: (Fig. 1a is the idiogram of the haploid set).

$$2n=45=A_6+B_{12}+B_3^s+C_{24}$$

Of the six long chromosomes, three are of one size and of similar morphology while the other three are slightly shorter and also morphologically similar. There are three medium-sized chromosomes which are morphologically similar, each bearing a pair of dot-like satellites. The rest of the chromosomes, either medium or short, are also in multiples of three similar ones. The karyotype, thus, is indicative of the autotriploid nature of this collection. The calculated absolute length of the chromosomes is 143.64μ . It was possible to get a few meiotic stages from the pollen mother cells in these plants. At meiotic metaphase I varying numbers of trivalents, bivalents and univalents were observed while at anaphase I many of the univalents were seen lagging or randomly scattered, some of them even in a state of division (Figs. 8 and 9). Associations such as these also provide additional proof of autotriploidy in these plants.

2. *Scilla indica* from Saidapet area (S-25).

The karyotype in these plants consists of $2n=45$ chromosomes (Figs. 2, 6, 7) and the karyotype formula is:

$$2n=45=A_8+B_6+B_3^s+C_{28}$$

Figs. 2a and 2b are the idiograms of the haploid sets of the two genomes involved in the composition of these triploids. The calculated absolute length is 131.95μ . The karyotype of this collection reveals certain features that are unique to this population. Of the eight long chromosomes, the longest (Chromosome No. 1 in idiogram

Figs. 1–2b. 1. Karyotype of *S. indica*-S-24, autotriploid. 1a, ideogram of its haploid set. 2, karyotype of *S. indica*-S-25, allotriploid. 2a, ideogram of the haploid set of its diploid genome. 2b, ideogram of its haploid genome.

2b) and another with almost median constriction (Chromosome No. 3 in idiogram 2b) have no homologues in the complement. Of the remaining six, two chromosomes (represented by chromosome 3 in the idiogram 2a) have subterminal con-

Figs. 3-9. Photographs and photomicrographs. 3, *S. indica*-S-24 full plant. 4, *S. indica*-S-25, full plant. 5, karyotype of S-24. 6 and 7, karyotypes of S-25 (two chromosomes out of field in fig. 6, full plate in fig. 7). 8, PMC of S-24 at M₁ showing trivalents, bivalents and univalents. 9, PMCs of S-24 at A₁ showing the lagging univalents in a state of division.

strictions and are morphologically similar. The remaining four chromosomes (chromosomes 1 and 2 in idiogram 2a) form two homologous pairs. There are three medium sized chromosomes, each with terminal satellites and one of them slightly

smaller than the other two. The rest of the chromosomes consist of some homologous pairs and the others as non-homologous individuals. Meiotic studies could not be made as the plants did not flower. The karyotype is indicative of the allo-triploid nature of this population.

Discussion

Raghavan and Venkatasubban (1939) while describing the three distinct karyotypes in *Scilla indica* with $2n=44, 45, 46$, collected from the Madras area, considered these as aneuploid chromosome races, the "broad-leaved" variety cytologically characterized by $2n=45$ chromosomes and the "narrow-leaved" variety by $2n=44, 46$. On considerations of the karyotypic and meiotic data they suggested a hybrid origin for *S. indica*, deriving it through crossing between a 16-chromosome species and a 20-chromosome species, the former contributing a triploid gamete ($8 \times 3=24$) and the latter contributing a diploid gamete ($10 \times 2=20$). They have also averred that "the absence of any known species of *Scilla* in India with either $2n=16$ or $2n=20$ makes one wonder if *S. indica* is an indigenous species at all!".

The present cytological study has very clearly shown that the Scillas occurring in the Madras area are well established triploids, all with the same chromosome number of $2n=45$ which fits in very well with the established basic number of 15 for the species in the country. These were mistaken to be diploids by the earlier workers since at that time the diploid number of $2n=30$, first reported by Sheriff and Murthy (1946) in *S. indica* was not known. The present work has further revealed the existence of two kinds of triploids in the area, the "broad-leaved" variety consisting of autotriploids and the "narrow-leaved" variety consisting of allotriploids. The most intriguing feature about these populations is that while the autotriploids (S-24) have the same types of chromosomes found in their diploid parts in the country, the allotriploids (S-25) are unique in possessing certain chromosomes, in particular the two long homologous chromosomes with subterminal centric constrictions, a type not encountered by the authors in any other population of *S. indica* in India. Such chromosomes on the other hand are very common in European Scillas. This naturally raises the question of the origin of these allotriploids containing the unusual chromosomes in the Madras area. Since such chromosomes are not found in the Indian Scillas other than these allotriploids one is led to surmise that the diploid set containing the two unusual chromosomes in the allotriploids might have been contributed by some diploid or tetraploid species of *Scilla* possessing such chromosomes which might have either existed in the coastal areas of Madras or might have been introduced into the area from somewhere in the past and which might have subsequently disappeared.

A noteworthy feature of these triploid populations is that both are sexually sterile. This disability is, however, amply compensated by the possession of very effective methods of vegetative propagation through prolific production of bulbils at the leaf tips as well as through the production of underground daughter bulbs. Cytogeographically, the Madras Scillas are very interesting in that both these triploid populations are found confined and isolated in the coastal areas of Madras,

and it is significant to note that the authors did not come across any *Scilla* other than these triploids in the Madras area nor did they come across any naturally occurring triploids anywhere in the country other than Madras during the cytological survey of the taxon in the country.

Summary

Scilla indica is widely distributed in central and southern parts of India and Sri Lanka, and is highly polymorphic, different populations in different geographical areas of the country looking like different species. Cytological studies on two phenotypically different populations of *S. indica* occurring in the Madras coastal areas have clearly revealed that both have the same chromosome number of $2n=45$ and evidently represent naturally occurring triploids fitting very well under the established basic chromosome number of 15 for the species in the country. These were mistaken to be diploids (aneuploid races) with $2n=44, 45, 46$ by the earlier workers apparently due to the reason that the diploid number of $2n=30$ was not known at that time. The present study has also revealed the existence of two kinds of triploids in the area, the broad leaved variety consisting of autotriploids and the narrow-leaved variety consisting of allotriploids. While the autotriploids have chromosomes similar to those found in their diploid counterparts, the allotriploids are unique in their diploid set having two long chromosomes with subterminal primary constrictions, a type not encountered in any of the Indian *Scillas* but very common in European *Scillas*. Both populations are sexually sterile. Nevertheless, they are found well established with effective means of vegetative propagation through prolific production of bulbils at the leaf tips and underground daughter bulbs. Cytogeographically these populations are very interesting in that they are found restricted and isolated in the coastal areas of Madras in India with no other kind of *Scilla* other than these triploids occurring in the area. It is also significant to record that in no other area in the country except Madras, did the authors come across any naturally occurring triploids of this species.

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