Cytological Studies in Two Species of *Dipcadi* Medic. from India

V. N. Naik

Department of Botany, Marathwada University, Aurangabad, Maharashtra, India

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The genus *Dipcadi* Medic. (Liliaceae) is represented in India by about eight species. Three of these are distributed in the Northern India, four are rather restricted to the Western India and one, namely *D. montanum* Baker, has a wider distribution. It is reported from the Northern India, Concan, Western Deccan (Hooker 1892) up to Belgaum in the South (Cooke 1907). It has now been collected from Aurangabad and its surrounding areas. Its occurrence in Orissa and other places in India, Africa and Madagascar as reported by Mahabale and Chennaveeraiah (1962) is not, however, supplemented by any published evidence.

Cytology of three African and three Indian species has been worked out so far. African species include *D. serotinum* with $2n=8$ (Sato 1942, Levan 1944), $2n=8+2-16B$ (Resende and Franca 1946) and $2n=8+0-1B$ (Fernandes *et al.* 1948), *D. glaucum* with $2n=18$ (Darlington and Wylie 1955) and *D. fulvum* with $2n=34$ (Bataglia 1954). The Indian species include *D. montanum* with $2n=20$, *D. saxorum* with $2n=12$ and *D. ursulae* with $2n=20$ (Mahabale and Chennaveeraiah 1954, 1962).

Materials and methods

The bulbs and flower buds of *D. montanum* were collected from Aurangabad and the surrounding areas while those of *D. saxorum* were collected from its type locality near Bombay. Root tips were pretreated with colchicine (0.01%). Materials were fixed in acetic-alcohol (1 : 3) and stained with aceto-orcein (1%).

Results

There are two distinct cytological races of *D. montanum* in this area; one, with $2n=12$ (Figs. 1a and 2a) and the other, with $2n=10$ (Fig. 5). The former grows on a muddy substratum and is rather robust, with deep green leaves and greenish flowers. The latter grows on poor rocky substratum and appears rather stunted, with pale green leaves and whitish flowers. Both of them grow on table-lands and are difficult to distinguish by qualitative morphological characters.

The plants make their appearance after the first showers in the monsoon i. e. during the third week of June, leaves and flowers appearing simultaneously. Aerial shoot is ephemeral and the entire life cycle is completed by the end of August ($2n=10$) or September ($2n=12$). Leaves in the both are narrow and 10-30 cm long. A solitary scape may be equally long or shorter with 15-20 flowers in a raceme. The flowers in most cases wither and drop off while one or two capsules may develop fully in

5–10% individuals.

The forms with $2n=12$ have two very long (5.3μ), four long (4μ) and six very short (1.5μ) chromosomes. All of them are acrocentric. The karyotype is asymmetrical and of a specialised type. Its absolute size is 35.6μ (Fig. 3a). Forms with $2n=10$ have essentially the same karyotype with the deletion of one of the very short pairs and, therefore, have absolute size of 32.6μ . No satellites have been

Figs. 1–3. 1, micrographs of root tips squashes of a, *D. montanum*. b, *D. saxorum*. $\times 3000$. 2, camera lucida drawings of somatic chromosomes at metaphase. a *D. montanum*. b, *D. saxorum*. both $\times 3000$. 3: Idiograms of somatic chromosomes. a, *D. montanum*. b, *D. saxorum*.

observed in any of these forms. Most of the cells show two nucleoli. The karyotype of *D. saxorum* is similar to that of *D. montanum* (Figs. 1b and 2b) but instead of having three very short pairs, it has two short pairs (each chromosome being 3μ long) and only one very short pair. Absolute size of the karyotype is 41.6μ (Fig. 3b).

Microsporogenesis in both the species is characterised by abnormal meiosis in large percentage of pollen mother cells, resulting in crumpled pollen. In about 5–7% of the flowers of *D. montanum* the meiosis was regular, showing six clear

bivalents (Fig. 4b) in form with $2n=12$ and five in forms with $2n=10$. In *D. saxorum* also six clear bivalents were observed except in some PMC's where two univalents along with the normal complement were recorded (Fig. 4a). These additional univalents have not been observed in the mitosis of roots and are probably lost during this division. Laggards have not been noted in any of the forms studied. Microspore tetrads of various kinds viz. linear, T-shaped, decussate and isobilateral were observed, the last one being the most common. Fertile pollen grains are binucleate at anthesis, monocolpate and monosiphonous.

The fruit formation is very rare but when capsules develop they contain a large number of viable seeds. The propagation is mainly by underground bulbs.

Figs. 4-5. 4, metaphase I in microspore mother cells. b, *D. montanum* $n=6_{II}$. a, *D. saxorum* $n=6_{II}+2_I$. both $\times 3000$. 5, somatic chromosomes in a form of *D. montanum* showing $2n=10$. $\times 3000$.

Discussion

The genus *Dipcadi* with over 40 species (Thiselton-Dyer 1898) is probably African in origin and has migrated to India via N-W India. This is evident from a large number of species reported from Africa and a few species restricted to N-W and Western India. With one of the species, *D. montanum*, occurring in Aurangabad and its surroundings, the distribution of the genus can now be extended eastwards to the Deccan plateau. *D. serotinum* appears to be a connecting link since it occurs both in Africa and India.

From the presently available data, the basic number for the genus appears to be $x=4$ and all the other numbers viz. $x=5, 6, 9, 10$ and 17 reported earlier are in most cases due probably to the presence of variable number of B-chromosomes. Polyploidy has not been recorded in any of the species studied so far. The possibility of polysomy and/or hybridization in the evolution of different species cannot be ruled out though there is no direct or indirect evidence in support of this assumption.

The karyotypes in all the species studied are asymmetrical with acrocentric chromosomes. These features are suggestive of relatively advanced or specialised status of the genus. This is also correlated with specialized floral structure and vessels are advanced beyond a primitive level and rather specialized (Cheadle and Kosakai 1971).

Out of six different basic numbers of chromosome reported in the genus so far $x=5$, 6 and 10 occur in two species viz. *D. montanum* and *D. saxorum*. The details are as follows:

D. montanum

$$2n=20; \quad 2VL+4L+8S+6VS$$

$$2n=12; \quad 2VL+4L+6VS$$

$$2n=10; \quad 2VL+4L+4VS$$

D. saxorum

$$2n=12; \quad 2VL+4L+4S+2VS$$

$$2n=14; \quad 6II \text{ as above} + 2I.$$

All the forms of *D. montanum* and *D. saxorum* have $2VL+4L$ and at least two short or very short chromosomes. This happens to be the basic complement of *D. serotinum* ($2n=8=2VL+4L+2VS$) also (Sato 1942).

The number of these short and very short chromosomes appears to vary in different species as well as different forms of the same species. These have been shown to be B-chromosomes in *D. serotinum* (Resende and Franca 1946, Fernandes *et al.* 1948)

In all probabilities, these short and very short chromosomes in *D. montanum* and *D. saxorum* are also B-chromosomes. This is evident from the following facts:

1. They vary in number among different individuals of the same species.
2. They are conspicuously smaller than the rest of the chromosomes and have not been observed to pair with them at meiosis but only with each other.
3. In *D. saxorum* they are seen at meiosis in PMC's but are probably lost at mitosis in roots.
4. There is no notable morphological variation in different cytological forms of the same species or even between two related species. The differences so far noted are all of quantitative nature only.
5. In natural population of *D. montanum*, forms with 4 and 6 very short chromosomes exist side by side in competition, although there is a minor edaphic preference.

It is too premature to predict anything in regard to the origin of the B-chromosomes in this genus. As there are two different sizes (short and very short) of chromosomes, they might have different origins in various species.

The habitat of the forms of *D. montanum* is also interesting in this connection. Forms with $2n=20$ are found in Western India, where there is heavy rainfall and thus high humidity. Forms with $2n=12$ and $2n=10$ are found in semi-arid regions of Marathwada with very low rainfall and dry weather. Even from the two latter forms those with $2n=12$ prefer muddy substratum and those with $2n=10$ are seen growing on poor, rocky substratum.

The adaptive significance of these B-chromosomes in *D. saxorum* is obscure

since both the forms ($2n=12$ and $2n=12+2B$) occur in the same locality.

It is clear that the genotypes in both the species discussed above are unstable at diploid level. This might be considered a step towards future polyploidy (Stebbins 1950). With the present knowledge no species can be considered an allo- or autopolyploid of any existing species.

The cytological studies in comparatively few species of this genus are not conclusively indicative of the variation patterns in the genus as a whole but certain evolutionary tendencies can be noted. For more reliable conclusions a detailed investigation of a large number of African and Indian species is essential.

Considering $x=4$ as the basic number for the genus and $2n=8$ (*D. serotinum* type) as a basic karyotype ($2VL+4L+2S$ or $2VS$) other karyotypes can be derived (Fig. 6). With the accumulation of more data on chromosome number, their morphology and breeding systems, all the Indian species may prove to be a single polytypic species.

Fig. 6. Hypothetical evolutionary trends in karyotypes of *D. montanum* and *D. saxorum* from *D. serotinum* like ancestor.

Summary

The cytological details of *D. montanum* Baker and *D. saxorum* Blatter have been presented. Both these species are at diploid level. *D. montanum* has $2n=20$, 12 and 10, while *D. saxorum* has $2n=12$ and 14 chromosomes. Variable chromosome numbers in both the species are probably due to the presence of B-chromosomes.

Irregular behaviour of chromosomes at meiosis and poor stainability of large percentage of pollen grains indicate high degree of sterility in these species. Regular bivalents were observed only in about 5–7% of the PMCs.

Formation of fruits and the development of viable seeds is very rare and propagation appears mainly through underground bulbs. Both the species have unstable genotype and appear active from evolutionary stand point.

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