Polyploidy in Genus *Crotalaria*

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Crotalaria is essentially an African genus of family Fabaceae. The 550 species that comprise it are important sources of a variety of alkaloids, fibres, ornamentals *etc.* Although studied cytologically by a number of workers from time to time, the genus has yet not even been scratched from the surface. Chromosome counts are known for only 156 species (Fedorov 1969, Boulter *et al.* 1970, Datta *et al.* 1973, Chennaveeraiah and Patil 1973, Nadkarni 1973, 1974, Bhatt 1974, Windler 1974, Patil and Chennaveeraiah 1975, Bhaumik 1975, Gupta and Gupta 1978a, b, Raina and Verma 1979, Sarkar *et al.* 1980, Patil 1987) which represents a mere 28.3% of the total species strength of the genus. Chromosome complements are known for still fewer taxa (Chennaveeraiah and Patil 1973, Gupta and Gupta 1978, Raina and Verma 1979, Mangotra 1982, Patil 1987).

Polyploidy and evolution

Of the 156 species for which the counts have been recorded 17 are polyploid. The percentage works at 10.9 which is higher compared to many other tribes and genera of family Fabaceae. In legumes as whole, the percentage polyploidy is 26.4. This figure includes the polyploids known for Papilionaceae, Casealpiniaceae and Mimosaceae. Familywise Casealpiniaceae harbours maximum polyploidy followed in order by Mimosaceae and Papilionaceae. In genus *Crotalaria* of Papilionaceae, the polyploids reported hitherto are tetra- or hexaploid; the actual breakup is 16 tetra- and one hexaploid. For the hexaploid species *C. ferruginea*, two different counts $2n=42$ (Bhaumik 1975) and $2n=48$ (Mangotra and Koul 1979) are on record (Table 1).

In Fabaceae as whole polyploidy is not considered a major evolutionary force. The existence of nearly 10.9% polyploids in genus *Crotalaria* suggests no mean role for this factor in the differentiation and evolution of new species. It is interesting to note that very few polyploid species of the genus exist in diploid state as well, indicating thereby that most of the polyploids are either paleo-polyploids whose diploid ancestors have become extinct or that chromosome doubling has diverged them so much from the diploid ancestors that it is difficult to match them now. *C. ferruginea* is an example of polyploid species of the genus whose diploid is on record (Mangotra 1982).

The genus *Crotalaria* includes two kinds of species the unifoliate and multifoliate types. The phylogenetic relationship between species of the two kinds are not linear but reticulate with the result that it cannot be said with certainty which of them is primitive and which one is derived. Perusal of the list of polyploid species of the genus reveals that polyploidy is almost limited to the unifoliate group. Since polyploidy is a derived feature, does it mean that unifoliates have been derived from the multifoliate taxa. Although the data on polyploidy are suggestive of such a conclusion, it is necessary to await data on other species. In this context, it is pertinent to refer to Verdoorn (1928) who states, that "If we assume that the more primitive of the Papilionaceae have pinnate leaves, it seems reasonable that other things being equal, the digitate, trifoliate and unifoliate types have been evolved in the order named, the unifoliate form being the most advanced."

A fact that emerges from the list of polyploid taxa is that, tetraploidy represents the optimum level. Thus, nearly 94 % of the polyploids recorded within the genus are tetraploid. In their work on the Indian legumes Bir and Kumari (1985) state that, "Majority of the polyploids in legume families are at the tetraploid level and there is general lack of higher grades of polyploidy". They include genus *Crotalaria* in the list of genera with predisposition for higher grades of polyploidy.

Fertility of polyploids

A basic handicap with polyploids is that they suffer with high degree of sterility. This is particularly true of the autopolyploids. In *Crotalaria* and similar other plants which reproduce only through seed, this shortcoming can eliminate polyploids in the very generation in which they evolve. A point of great interest is that all polyploid species of *Crotalaria* are seed fertile. The fertility is comparable to the allied diploid taxa (Mangotra 1982). This feature accounts for the success of polyploids and circumvents the bottleneck which could otherwise reduce their potential in evolution.

Table 1. Polyploid species of *Crotalaria*

S. No.	Species	Chr. No. (2n)	Ploidy level	Reference
1.	<i>Crotalaria pumila</i>	32	4x	Atchison (1950)
2.	<i>C. pilosa</i>	32	4x	Atchison (1950)
3.	<i>C. sagittalis</i>	32	4x	Turner and Fearing (1960)
4.	<i>C. stipularia</i>	32	4x	Turner and Irwin (1961)
5.	<i>C. paulina</i>	32	4x	Shibata (1962)
6.	<i>C. massaiensis</i>	32	4x	Boulter <i>et al.</i> (1970)
7.	<i>C. nitens</i>	32	4x	Chennaveeraiah and Patil (1973)
8.	<i>C. bupleurifolia</i>	32	4x	Windler (1974)
9.	<i>C. nayaritensis</i>	32	4x	Windler (1974)
10.	<i>C. polyphylla</i>	32	4x	Windler (1974)
11.	<i>C. purshii</i>	32	4x	Windler (1974)
12.	<i>C. quercetorum</i>	32	4x	Windler (1974)
13.	<i>C. rotundifolia</i> var. <i>vulgaris</i>	32	4x	Windler (1974)
14.	<i>C. humifusa</i>	32	4x	C. f. Verma and Raina (1980)
15.	<i>C. foliosa</i>	32	4x	C. f. Patil (1987)
16.	<i>C. velutina</i>	32	4x	C. f. Patil (1987)
17.	<i>C. ferruginea</i>	42	6x	Bhaumik (1975)
	<i>C. ferruginea</i>	48	6x	Mangotra and Koul (1979)

Fertility of polyploid crotalaris is due to their stable meiotic system. Irrespective of the degree of polyploidy, chromosomes always pair in two's. As a consequence, polyploid meiosis is characterised by bivalent formation. This has been used as an argument to consider the polyploids as allopolyploids. This deduction is quite safe because autopolyploids also resort to bivalent formation under certain circumstances. The case of 5BL system of hexaploid wheat is a classical example. Moreover, interspecific hybridization in *Crotalaria* is extremely difficult to achieve.

Induced polyploidy

In view of the superiority of polyploids attempts have been made to induce polyploidy in number of flowering plants. In genus *Crotalaria* polyploidy has been induced in *C. goreensis* (Bouharmont 1961), *C. sericea*, *C. retusa*, *C. juncea* and *C. browneii* (Gupta and Gupta 1975) by treating seeds with aq. solutions of colchicine. The major drawback with induced polyploids

is that they are sterile and they revert to diploidy within a few generations. The fate of induced polyploids of *Crotalaria* has not been recorded. Work on induced polyploidy in *Crotalaria* can be interesting from the point of view of its impact on alkaloid content, fibre length etc. for which some species of the genus are cultivated.

Polyploidy in relation to base number

Crotalaria is a dibasic genus with 7 and 8 as the two base numbers. Of the 156 species for which chromosome counts are on record, 148 have counts based on x , 8 and in the remaining 8 the number is a multiple of 7. Only two species namely *C. polysperma* and *C. medicaginea* exist in chromosome races, one with $n=8$ and the other having $n=7$ (Boulter *et al.* 1970). Great deal of debate has been going on to establish which of these two chromosome numbers represent the ancestral count. Some favour 7 and others 8 for this purpose. The study of polyploids throw some light on this problem. Table 1 reveals that 17 of the 18 polyploid taxa are based on $x=8$. *C. ferruginea* is the only species in which a polyploid with $2n=42$ has been reported. Even in this species Mangotra and Koul (1979) put the number at $2n=48$ which is a hexaploid count based on x , 8. As it is, all polyploids except the doubtful count of *C. ferruginea* are based on base number 8. This strengthens the credibility of 8 as the primary base number of the genus.

Summary

The paper evaluates the degree of polyploidy in the leguminous genus *Crotalaria*, discusses its role in intragenetic evolution, impact on plant fertility and significance in solving the problem of base number of the genus.

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