Chromosome Numbers in Some North West Indian Species of *Polygala*

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Polygala is the largest genus of the otherwise small family Polygalaceae. Its members are herbs, undershrubs or shrubs which are distributed in the temperate and warmer regions of the world. Lawrence (1951) listed about 475 species under the genus whereas according to Mukherjee (1958), it is one of the largest genus of angiosperms with nearly 1,000 species. According to Willis (1973), there are about 500-600 species of *Polygala* in the world. In the Indo-Burmese region, the genus is represented by about 30 species of which about 9 species are found in N. W. India (cf. Mukherjee, l. c.).

Cytologically, this is a very imperfectly known genus. Chromosome numbers for a total of only 45 species have so far been reported from various parts of the world. Of these, a total of 24 species have been reported by Lewis and Davis (1962) alone and 10 species by Glendenning (1960). A single species *P. chinensis* is cytologically reported from India by Mitra and Datta (1967). The paucity of chromosomal data for the genus *Polygala* may perhaps be due to the fact that the meiotic studies are little difficult in this genus. This is because of the very low number of pollen mother cells in the anther, poor stainability and small size of chromosomes, exceptionally long duration of the prophase I and the high chromosome number. Also, the stages between prometaphase I and telophase I are deceptive because some of the chromosomes stain very lightly thus making the counts uncertain.

Material and methods

Material for meiotic studies was procured from populations growing in and around Chandigarh in the plains and the Nainital and Kashmir hills in the Himalayas. The young flower buds were fixed in 1:3 acetic alcohol for 24 hours and later transferred to 85% alcohol. The squashing of the anthers was accomplished in 2% aceto-carmin which was presaturated with iron acetate. Five to six populations of each species were usually screened to confirm the chromosome number and to study the meiotic abnormalities, if any. The voucher specimens have been deposited in the Herbarium of the Botany Department, Panjab University, Chandigarh. All the camera lucida drawings are at a uniform magnification of $\times 2250$.

Results and discussion

Table I summarises the results of cytological observations on 11 taxa belonging to 8 species of the genus *Polygala*. The course of meiosis was normal in all the

taxa with nearly 100% pollen fertility.

A perusal of the chromosomal data for the various species of *Polygala* reveals a great diversity in the chromosome numbers with $2n=14, 16, 24, 28, 30, 32, 34, 36, 38, 40, 42, 46, 52, 56, 68, 72$ and 96 reported by various workers for the different species of the genus (see Fedorov 1969 and Moore 1973). These reports suggest a great burst of polyploidy and aneuploidy associated with hybridization during the diversification and expansion of the genus.

Lewis and Davis (1962) regarded the genus *Polygala* to be based on four primary basic numbers $x=6$ (12), 7 (14), 8 and 10 and $x=17, 19$ and 23 as secondary base

Table 1.

Species	Locality	n-chromosome number	Fig. no.	Previous reports
* <i>Polygala abyssinica</i> R.Br. ex Frens.	Bhimtal, Nainital 1300 m	19	1	
+ <i>P. chinensis</i> Linn. var. <i>linarifolia</i> (Willd.) Chodat	University campus, Chandigarh 300 m	14	2	$n=24$: Mitra and Datta (1967)
* <i>P. crotalarioides</i> Buch-Ham. ex DC.	Bhimtal, Nainital 1300 m	14	3	
+ <i>P. erioptera</i> DC.	Lake side, Chandigarh 300 m	38	4	$2n=38$: Hagerup (1932)
	Surajpur, Chandigarh 350 m	38		
* <i>P. longifolia</i> Poir.	Pehlgam, Kashmir 1800 m	19	5	
* <i>P. persicariaefolia</i> DC.	Srinagar, Kashmir 1500 m	14	6	
	Jeolikote, Nainital 1300 m	14		
+ <i>P. sibirica</i> Linn. var. <i>monopetala</i> (Camb.) Chodat	Gulmarg, Kashmir 2400 m	17	7	$2n=68$: Sokolovskaya (1966)
* <i>P. triphylla</i> Buch- Ham. ex D. Don	Laria Kanta, Nainital 2200 m	28		
	Pehlgam, Kashmir 1800 m	28	8	

* Species investigated for the first time.

+ New report for the species (new cytotype).

numbers. The base number $x=7$ was considered by these authors to be the original base number of the genus from which all the other numbers met with in the various species were derived. Their conclusions were based on the fact that most of the species investigated till then were based on this number and they possessed most diverse morphology as compared to species based on any other number. They further postulated the derivation of $x=8$ (9) and $x=10$ by chromosomal gain and of $x=6$ by chromosomal loss from the original base number $x=7$. The secondary base number $x=19$ was proposed to have arisen by combination of the parental stock with $x=6+6+7$. Similarly, $x=17$ and $x=23$ were proposed to have origi-

Figs. 1-8. 1, *Polygala abyssinica*, $n=19$. 2, *P. chinensis* var. *linarifolia*, $n=14$. 3, *P. crotalaroides*, $n=14$. 4, *P. erioptera*, $n=38$. 5, *P. longifolia*, $n=19$. 6, *P. persicariaefolia*, $n=14$. 7, *P. sibirica* var. *monopetala*, $n=17$. 8, *P. triphylla*, $n=28$.

nated by suitable combinations of the lower basic numbers.

So far as the present authors are aware, no species with $n=6$ have so far been reported in the genus *Polygala* nor is there any indication of the base number $x=6$ being represented in the species with higher haploid numbers. The species with $n=12$ could very well be based on $x=12$ and those with $n=18$ on the base number $x=9$. The base numbers $x=7$ and 8 which are probably the primary base numbers, are represented in one or more of the species known cytologically. In addition, the genus shows a secondary basic series with $x=10, 12, 13, 14, (15), 17, 19$ and 23. It is felt that the original base number of the genus *Polygala* was in all probability $x=7$, which incidently, is also the lowest haploid number reported so far, for any species of the genus. From this original base number, the base number $x=8$ could have originated by chromosomal gain and the basic numbers $x=10, 12$ and 13 could have been derived from $x=14$ by descending aneuploidy. The base number $x=14$ in this random sample might have possibly been derived from $x=7$. The secondary base number $x=19$ could have originated by hybridization between species based on $x=7$ and those with $x=12$ followed by chromosome doubling. Similarly, the origin of $x=17$ could be visualised from the species based on $x=7$ and $x=10$ and of the basic number $x=23$ by suitable combinations of the lower basic numbers.

Of the 8 species of *Polygala* investigated here, *P. chinensis* var. *linarifolia* ($n=14$), *P. crotalarioides* ($n=14$), *P. persicariaefolia* ($n=14$) would be tetraploids and *P. triphylla* ($n=28$) an octaploid on the base number $x=7$. Similarly, *P. abyssinica* ($n=19$) and *P. longifolia* ($n=19$) are both secondary diploids and *P. erioptera* ($n=38$) secondary tetraploid on the sec. base number $x=19$. *Polygala sibirica* var. *monopetala* in the present studies with $n=17$ would be a secondary diploid on the base number $x=17$.

Out of a total of about 40 species that has been cytologically investigated so far, primary diploid based on $x=7$ was reported by Hsu (1967) in *Polygala japonica* var. *angustifolia* ($n=7$) alone and the primary diploid based on $x=8$ was reported by Lewis and Davis (1962) in *P. scoparia* ($n=8$). The rarity of species having $n=7$ or $n=8$ may perhaps be due to the differential extinction of these primitive diploids. Secondary diploids and polyploids which in all probability are amphipolyploids are reported in as many as 38 species which work out to 95% polyploidy. Thus, the genus *Polygala* is far more rich in the incidence of polyploidy than the angiosperms in general, which have only 30–35% polyploids.

Aneuploidy in the genus *Polygala* is equally common as evidenced by the dysploid series with basic numbers $x=7, 8, 10, 12, 13, 14, (15), 17, 19$ and 23. The known chromosome numbers in *Polygala amara* with $2n=28, 34$ ($x=14, 17$); *P. chamaebuxus* with $2n=38, 44, 46, 48$ ($x=19, 22, 23, 24$); *P. comosa* with $2n=28, 32, 34$ ($x=14, 16, 17$); *P. serphyllifolia* with $2n=32, 34, 68$ ($x=16, 17$) and *P. vulgaris* with $2n=28, 32, 56, 68, 70$ ($x=14, 16, 17$) (cf. Fedorov, l. c.; Moore, l. c.) are all cases of multiple basic numbers and/or aneuploid reduction or increase of the different basic numbers.

From the foregoing discussion, it seems evident that numerical chromosomal changes coupled with hybridization have played a significant role in the evolution

and speciation within this polymorphic genus. A critical correlation of the cytological and the morphological data is desired to understand the process of evolution and the status of taxa and species in the genus *Polygala*.

Summary

Meiotic studies in 11 taxa comprising of 8 species of *Polygala* (family Polygalaceae) have been carried out. Five species marked* in Table 1 have been investigated for the first time and new chromosome numbers have been made available for the remaining 3 species marked+ in the same Table. A normal course of meiosis was characteristic of all the species investigated here. The genus *Polygala* is proposed to have been evolved from ancient stock of species based on $x=7$, a base number still preserved in the genus.

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