CHAPTER IV

DISCUSSION

S O L A N A C E A E

DISCUSSION

SOLANACEAE

Importance of chromosome counts in systematic and breeding studies has been realised by researchers right from the early 20th century. Large number of researchers have attempted in this direction. As a result of their studies many 'chromosome count' reports have been published for the members of the family Solanaceae. These have been profitably used for reshuffling the family for phylogenetic realignment at tribal, generic or specific levels. Important contributions are made by Vilmorin & Simonet (1927, 1928), Jörgensen (1928), Bhaduri (1933), Sugiura (1940), Oinuma (1945, 1949), Darlington & Janaki Ammal (1945), Stebbins & Paddock (1949), Menzel (1951), Sinha (1951), Gottschalk (1954, 1956, 1958), Baylis (1958, 1963), Blakeslee *et al*. (1959), Roe (1967), Randle & Symon (1976). Based on the above mentioned studies base numbers 3, 4, 6, 7, 8, 9 + isochromosome, 10, 11, 12, 14, 17, 23 and 30 are proposed for the family Solanaceae.

Sugiura (1940) is of the opinion that the base number for the family is 6 which is derived from the theoretical base number 3 observed in allied families Nolanaceae and Scrophulariaceae. While, Wanscher (1934) based on his observations of secondary association of chromosomes in the members of the family suggested 4 as the base number. In contrast to the

above mentioned two suggestions, Ellison (1936) considers 6 or 12 as the base numbers which are metwith in majority of the taxa of the family. Recently Rao (1979) also opioned that 6 is the likely base number and the existing, accepted base number i.e. X = 12 is of secondary polyploidy in origin. However, in the present study of 18 species belonging to 5 genera, base number 12 is encountered in 4 out of 5 genera. While monotypic genus Nicandra revealed the presence of X = 9 or 10, which support the base number 12 for the family, from which other numbers might have originated through duplication or by aneuploidy, resulting in loss or gain of few chromosomes.

The diploid number 2n = 19, 20 and 21 have been reported for the monotypic genus Nicandra by Vilmorin & Simonet (1928), Janaki Ammal (1932), Darlington & Janaki Ammal (1945), Delay (1947), Sinha (1951), Gottschalk (1954) and Venkateswarlu & Rao (1962). In the present study one population showed 2n = 19 while the other 2 showed 2n = 20 in their somatic complements. This is in agreement with the previous reports of Darlington & Janaki Ammal (1945) for 2n = 19 and 2n = 20 by Vilmorin & Simonet (1928), Janaki Ammal (1932), Delay (1947), Gottschalk (1954) and Venkateswarlu & Rao (1962). 2n = 21 reported by Sinha (1951) is not observed in the present study. The presence of 9 distinct bivalents at diakinesis suggest that the primary base number for the genus is X = 9 or 10. However, one or two

isochromosomes are observed along with the normal pairing bivalents in PMC's. In the genus Nicandra species formation seems to be at a standstill and N. physalodes is the only representative of the genus. The isochromosomes, present therein might have arisen either from the ordinary chromosomes by misdivision of the centromere or by misdivision of the telocentric chromosome which undergo sister reunion of chromatids within the centromeres. Such isochromosomes at times may form pair or may remain univalents. Pollens and eggs lacking an isochromosome, formed by the loss of such univalents. If and when fusion of such a gamete takes place with the normal one, it results in producing plants having 2n = 19. In nature, populations having 2n = 19 and 2n = 20, both survive indicating thereby the adaptive significance of the isochromosomes like that of supernumary chromosomes. Isochromosomes may be responsible for genetic reconstruction which help in providing necessary means for adaptation to the changing environments.

The present study of genus Lycium confirms the previous reports of 2n = 24 and n = 12 by Sugiura (1936), Ratera (1944) for various species of the genus. This therefore, supports the earlier contention of considering X = 12 as the base number for the genus.

Based on the reports of Bhaduri (1933) and Miege (1960), X = 12 has been suggested as the base number for the genus

Withania. In the present study of W. somnifera n = 24 and 2n = 48 are recorded. This substantiates the earlier suggested base number for the genus.

Study of the genus Physalis by workers such as Vilmorin & Simonet (1928), Menzel (1951) and Sinha (1951) indicate that in majority of the species either n = 12 or 2n = 24 is observed. This suggests that the base number for the genus could be X = 12. Both the species viz., Physalis longifolia and P. minima studied presently show 2n = 48 and n = 24. Therefore, X = 12, the suggested base number for the genus is confirmed and the 2 species analysed presently represent tetraploid forms derived from forms with X = 12.

Two base numbers X = 12 and X = 23 have been suggested for the genus Solanum by a number of workers. Prominent among them are Winge (1925), Jörgensen & Crane (1927), Vilmorin & Simonet (1928), Hruby (1934, 1957), Bhaduri (1933), Tischler (1934), Tokunaga (1934), Janaki Ammal (1935), Nakamura (1937), Rohweder (1937), Oinuma (1945, 1949), Westergaard (1948), Swaminathan (1949), Stebbins & Paddock (1949), Polya (1950), Gottschalk (1954), Löve (1954), Okable (1955), Baylis (1958), Diers (1961), Sharma & Bal (1961), Mulligan (1961), Masubuchi (1961), Nanda (1962), Venkateswarlu & Bhirvamurthy (1962), Shibata (1963), Chuang (1963), Bezbaruah & Bezbaruah (1963), Skalinska (1964), Borgmann (1964), Tandon & Rao (1964, 1966), Baquar et al. (1965),

Gadella & Kliphuis (1967), Chennaveeraiah & Patil (1968), Randall & Symon (1976) and Kuriachan (1980). Based on the studies of Michael and others, D' Arcy (1974) has reported the existence of two stray base numbers X = 11 and X = 36 for the genus. Of the Solanum species included in the present study 6 have 2n = 24 and n = 12; 4 have 2n = 48 and n = 24 and 3 species and one form (red veined leaf) have 2n = 72 and n = 36. All the taxa worked out presently represent diploid, tetraploid and hexaploid forms derived from the basic genome having X = 12. Within the genus speciation must have taken place through natural hybridization, polyploidization accompanied by structural alterations. Base numbers X = 11, X = 23 and X = 36 are not observed in any population of the species analysed presently.

For karyotypic analysis precise determination of arm ratios of chromosomes is made. Among the species of all the five genera studied, majority of them revealed the presence of chromosomes with nearly median or nearly submedian centromeres. Moreover, the calculated values of TF% from 31.75% to 37.34% indicate the asymmetrical nature of the karyotypes. However, the degree of asymmetry varies with the types of the chromosomes, L/S ratio and ploidy level of the complement.

Based on the above mentioned criteria among the five genera, genus Nicandra can be considered primitive followed by Lycium. While because of highly polymorphic nature of the genus accompanied by morphological diversities, different chromosome

numbers (2n = 24 to 72 or more), high ploidy levels, more asymmetrical nature of the karyotypes, the genus Solanum can be considered most advanced among the genera studied presently. The remaining 2 genera viz., Withania and Physalis occupy a position in between Lycium and Solanum.

Workers like Levitsky (1931), Stebbins (1950) have suggested, that the symmetry of the karyotype is an indication of the degree of specialization of a species. So an asymmetrical karyotype would be characteristic of an advanced species as compared with the symmetrical karyotypes. Considering this as true representation of evolutionary trend the 12 species and one form of the 5 genera investigated are arranged accordingly.

The monotypic genus Nicandra is represented by single species viz., N. physalodes. The somatic complement of this species contains 20 chromosomes. The primitive nature of the species is evidenced in its karyotype. The chromosomes within the complement are ranging between 1.639 μ to 2.489 μ having a mean length of 1.06 μ. The complement contains 6 chromosomes with nearly median and 12 chromosomes with nearly submedian centromeres accompanied by 2 isochromosomes. The karyotype has only one pair of secondarily constricted chromosomes represented by $F^{S'}$-type. Low values of L/S ratio and comparatively high value of TF% also indicate the primitiveness of the taxa.

Only one species of the genus Lycium viz., L. barbarum has been investigated in the present work. The somatic complement of 24 chromosomes show the presence of comparatively longer chromosomes i.e. between 2.656 μ to 4.689 μ having 1.79 μ mean length. Within the karyotype there are as many as 10 pairs with nearly submedian and only 2 pairs with nearly median centromeres and a pair of satellited chromosomes. Slightly more asymmetrical nature of the karyotype is also evidenced by L/S ratio (1.76) and TF% (31.75%). These indicate its advance nature of the karyotype over the preceeding taxon.

The karyotype of Withania somnifera depicts marked advancement over the karyotype of Lycium barbarum in having 2n = 48 chromosomes. In the somatic complement it has 19 pairs of chromosomes with nearly submedian and 5 pairs with nearly median centromeres. In contrast to the presence of one pair of satellited chromosomes in the complement of Lycium, the complement of this taxon has 2 pairs of satellited chromosomes. The karyotype also shows advancement in reduced length of chromosomes, less value of mean length and the asymmetry of the idiogram.

Two species of Physalis viz., P. longifolia and P. minima investigated presently show advancement of the genus over previously described genus Withania. Both species of Physalis have 2n = 48 chromosomes in their somatic

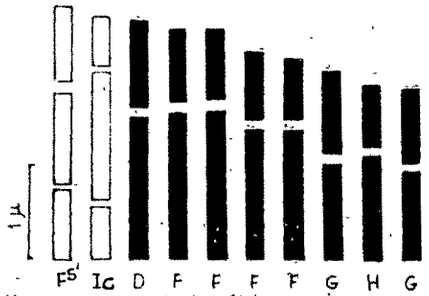
complement. Also values of total chromatin length, mean length of chromosomes are more or less the same. In the complements of both the species there are 5 pairs of chromosomes having secondary constrictions and/or satellites. Minor structural differences in number of each type of chromosomes accompanied by values of L/S ratio and TF% are the criteria to distinguish the karyotypes of the two species. P. minima has 10 pairs with nearly median and 14 pairs with nearly submedian centromeres. Among the 5 pairs, 3 are satellited and 2 are with secondary constrictions on long arms. The value of L/S is slightly low i.e. 2.18 and TF% is comparatively high i.e. 36.36%. In contrast to this the somatic complement of P. longifolia has 6 pairs with nearly median and 18 pairs with nearly submedian centromeres. Moreover, all the 5 chromosome pairs are satellited. No chromosome pair with secondary constriction is observed. Besides these features, values of L/S ratio (2.70) and TF% (32.31%), also indicate the advance nature of the karyotype over P. minima (Pl.4:1).

In the present study of the genus Solanum 12 species and one form of S. nigrum have been investigated. Among these are, 3 morphologically distinct spinous species, S. viarum, S. trilobatum and S. heterodoxum. Of the remaining Solanum species, S. nodiflorum, S. nigrum, S. roxburghii, S. purpureilineatum and a form of Solanum showing red veined leaves, were collected from various localities in Gujarat.

Pl. 4:1 Comparison of idiograms of different members of family Solanaceae.

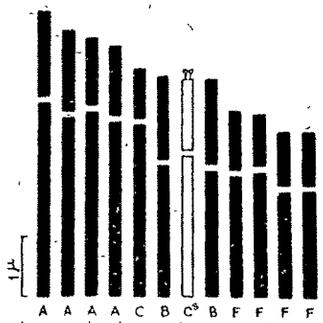
1. Nicandra physalodes
2. Lycium barbarum
3. Withania somnifera
4. Physalis minima
5. P. longifolia

Contd...



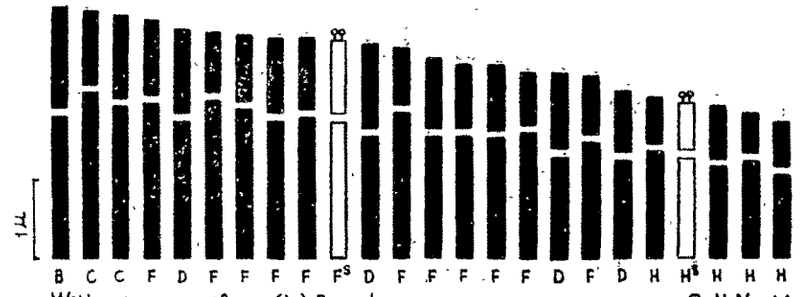
Nicandra physalodes (L.) Gaertn Coll No 8

1



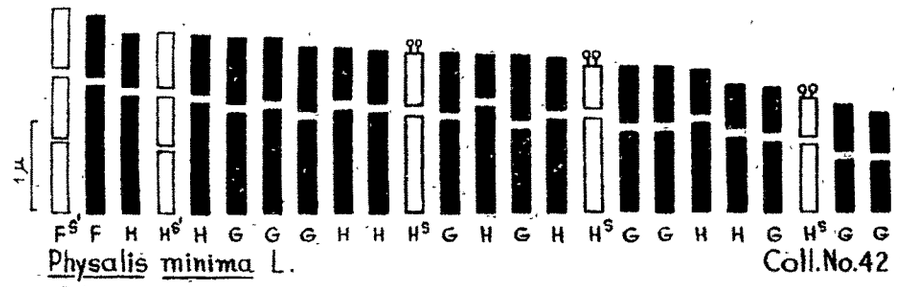
Lycium barbarum L. coll No 15

2



Withania somnifera (L.) Dunal Coll.No.14.

3



Physalis minima L. Coll.No.42

4

Physalis longifolia Nutt. Coll.No.41

5

PLATE - 4:1

All these have been placed in S. nigrum proper in earlier works. As mentioned earlier, the polymorphism and differences in vegetative and reproductive features are marked enough to recognise them as distinct species. Populations of this complex, collected from different localities in Gujarat have been analysed following Heiser et al. (1965) which also substantiates the earlier findings of Bhatt (1971 unpub.) based on polygraphic study of S. nigrum complex in Gujarat.

All the 3 spine bearing species are diploid showing 2n = 24 and n = 12 chromosomes. Among them S. trilobatum in its complement has equal number of chromosome pairs with nearly median and nearly submedian centromeres, while S. heterodoxum and S. viarum have less number of pairs with nearly median (D-type) and more number of pairs with nearly submedian (C, F & H-types) centromeres. The calculated values of TF% for these species also indicate the same trend. S. trilobatum, having more number of chromosome pairs with nearly median centromeres and comparatively longer chromosomes, should be considered primitive among the three. Between the remaining 2 species, S. heterodoxum and S. viarum having comparatively short chromosomes, S. heterodoxum appears less evolved, as it has 4 pairs of chromosomes with nearly median centromeres, while S. viarum has only 2 pairs(Pl. 4:2).

The karyotype study reveals the presence of different ploidy levels among the species of S. nigrum complex.

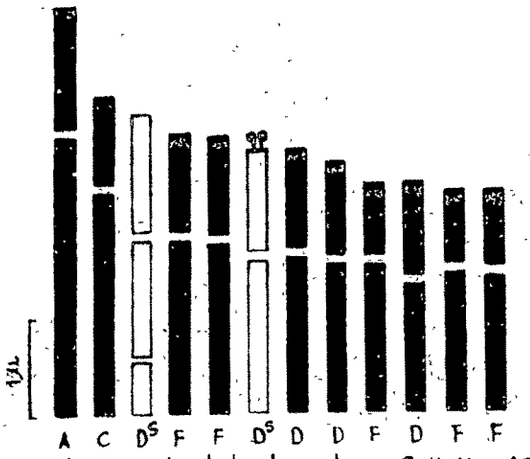
Pl. 4:2 Comparison of idiograms of the spinaceous species of the genus Solanum.

6. S. trilobatum

7. S. heterodoxum

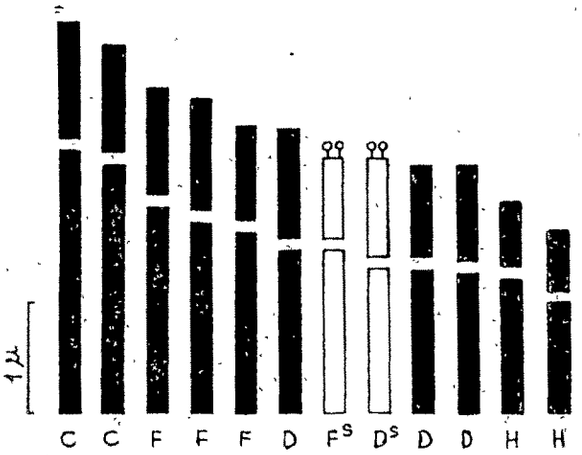
8. S. viarum

Contd...



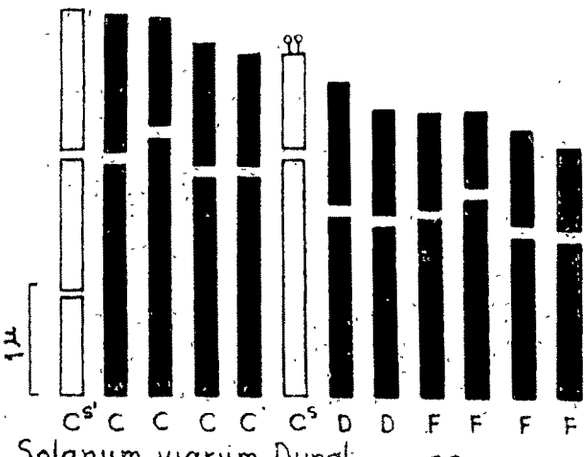
6

Solanum trilobalum L. Coll. No. 48



7

S. heterodoxum Dunal Coll No 34



8

Solanum viarum Dunal COLL NO 25

PLATE - 4:2

2 species, S. nodiflorum and S. nigrum are diploid having 2n = 24; 2 species S. roxburghii and S. purpureilineatum are tetraploid having 2n = 48 and 2 populations of S. nigrum and one form showing red veined leaves, are hexaploid having 2n = 72.

The envisaged close relationship among the above mentioned species is evident through size and types of chromosomes in their complements. The resemblance of the karyotype is also noticed in their having more number of chromosome pairs with nearly submedian centromeres, in presence of at least one pair of secondarily constricted and satellited chromosomes in majority of the populations. The calculated values of mean length and TF% for the somatic complements of different populations of these species are more or less comparable (Table 4:1) and the same is also reflected in the idiograms showing the nature of symmetry and the gradation of the karyotypes.

The karyotypes of S. nodiflorum and S. nigrum, the two diploid species, appear less evolved than the tetraploid and hexaploid species of the complex. However, between the 2, S. nigrum having longer chromosomes, more number of chromosome pairs with nearly median centromeres and slightly higher value of TF% may be considered little less evolved than S.nodiflorum. (Pl.4:3).

The karyotypes of 2 tetraploid species of the complex

Pl. 4:3 Comparison of idiograms of diploid taxa of the genus Solanum.

9. S. americanum

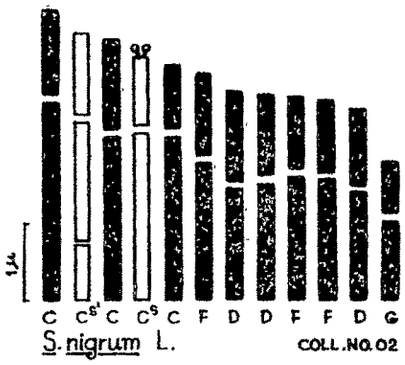
10. S. nigrum

11. S. nodiflorum

Contd...

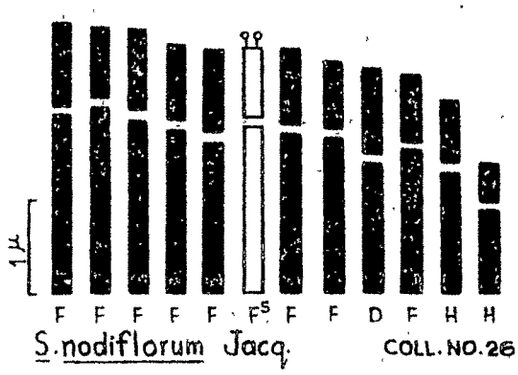
9

Solanum americanum Mill. Coll.No.35



10

S. nigrum L. COLL.NO.02



11

S. nodiflorum Jacq. COLL. NO. 26

PLATE - 4:3

i. e. S. roxburghii and S. purpureilineatum, show slight advancement over the preceeding species. The chromosomes are shorter and the complement contains more pairs of chromosomes with nearly submedian centromeres. The values of TF% and mean length also indicate the same. The karyotypes of the 2 tetraploid species also resemble each other as regards the number of chromosome pairs having nearly submedian centromeres, satellited and secondarily constricted chromosomes. However, between the two, S. roxburghii appears comparatively evolved in showing more number of chromosomes with nearly submedian centromere and higher value of L/S ratio. However, occurrence of B-chromosomes recorded in some populations of S. purpureilineatum is not seen in any populations of S. roxburghii analysed (Pl. 4:4).

The hexaploid populations, of S. nigrum and red veined form of the same, also resemble each other in gross karyotypic details. The resemblance of them is also observed with diploid population of S. nigrum in certain respects. However, between the two hexaploids, the karyotype of S. nigrum having more pairs of chromosomes with nearly median centromeres, comparatively longer chromosomes and higher value of TF%, be considered comparatively less evolved than the red veined form of S. nigrum. In all probabilities the red veined form has come into its being by structural alterations in the basic karyotype of hexaploid S. nigrum and/or by hybridization of the related species (Pl. 4:5).

Pl. 4:4 Comparison of idiograms of tetraploid taxa of the genus *Solanum*

12. *S. villosum* subsp. *villosum*

13. *S. villosum* subsp. *puniceum*

14. *S. purpureilineatum*

15. *S. roxburghii*

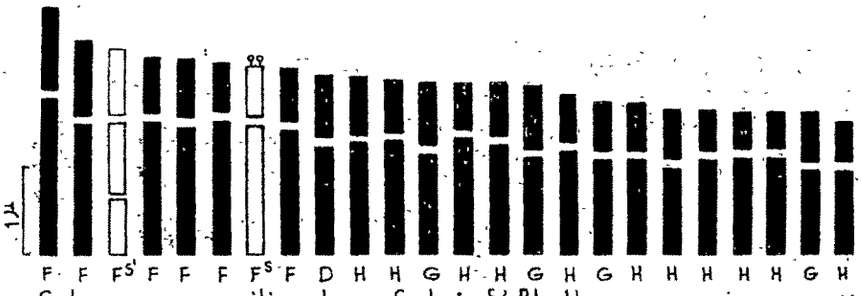
Contd....

12

Solanum villosum Mill. subsp. villosum COLL. No 31

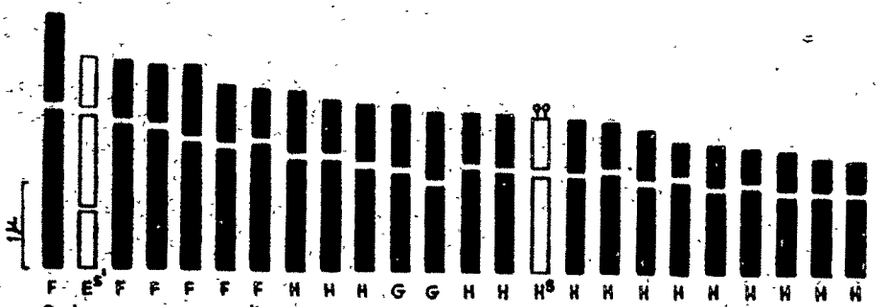
13

S. villosum Mill. subsp. puniceum (Kirchleger) Edmonds Coll.No.32



14

Solanum purpureilineatum Sabnis & Bhatt COLL.NO 11



15

Solanum roxburghii Dunal Coll.No.6

PLATE - 4:4

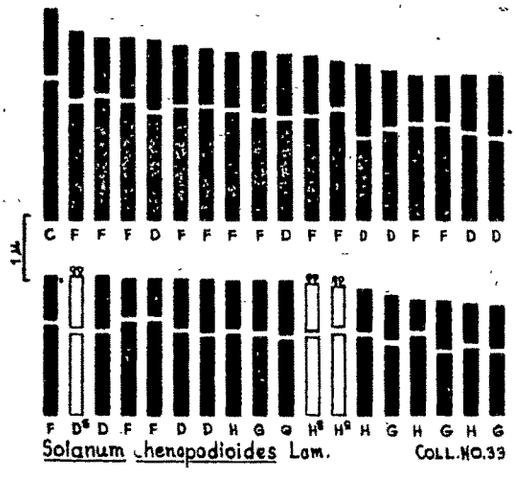
Pl. 4:5 Comparison of idiograms of hexaploid taxa of the genus Solanum

16. S. chenopodioides

17. S. scabrum

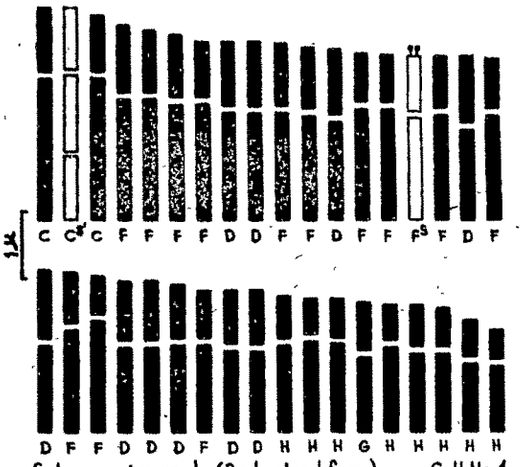
18. S. nigrum (Red veined form)

19. S. nigrum



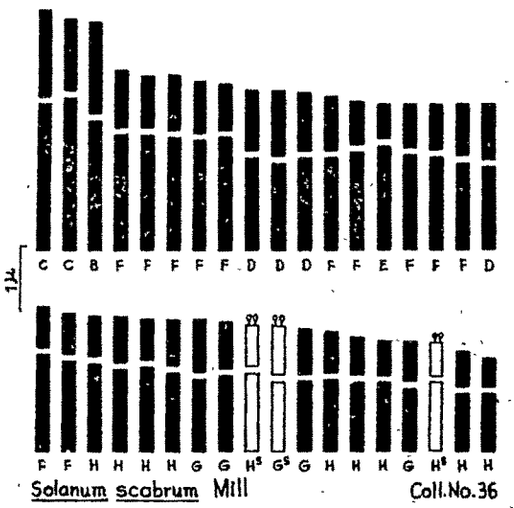
Solanum chenopodioides Lam. Coll.No.33

16



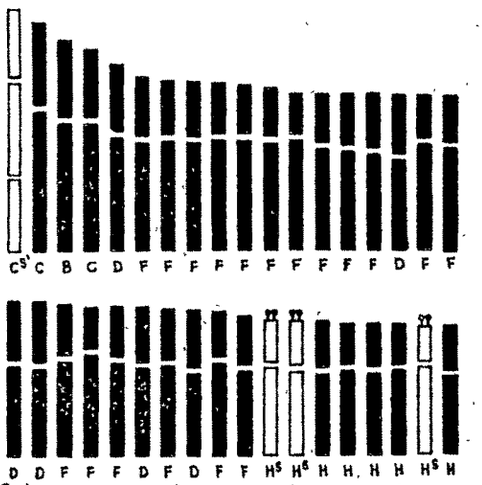
Solanum nigrum L. (Red veined form) Coll.No.4

18



Solanum scabrum Mill Coll.No.36

17



Solanum nigrum L. Coll.No.30

19

PLATE - 4:5

Based on the foregoing discussion, different species of S. nigrum complex of Gujarat can be tentatively placed in the following evolutionary sequence :

S. nigrum (diploid), S. nodiflorum, S. roxburghii, S. purpureilineatum, S. nigrum (hexaploid), S. nigrum (red veined form).

In the present study, an attempt is also made to analyse some recognised exotic species belonging to S. nigrum complex. Among these species also, diploid population of S. americanum, tetraploid populations of S. villosum subsp. villosum, S. villosum subsp. puniceum and hexaploid populations of S. chenopodioides and S. scabrum are encountered.

The karyotype of diploid population of S. americanum has 5 pairs of chromosomes with nearly median and 7 pairs with nearly submedian centromeres. Though the complement contains 3 pairs of satellited chromosomes, L/S ratio and TF% suggest little less evolved nature of the taxon when compared with other two diploid species of this complex from Gujarat (Pl.4:3)

The gross resemblance of the karyotypes of 2 exotic tetraploid species viz., S. villosum subsp. villosum and S. villosum subsp. puniceum with the karyotypes of S. roxburghii and S. purpureilineatum is observed. Recent studies by Bhirvamurthy & Rathy (1981) concerning amino acid pattern also indicate close relationship of tetraploid taxa. But

S. villosum subsp. villosum representing the type species shows primitiveness of the karyotype over the karyotype of S. villosum subsp. puniceum. The advanced nature of the latter is seen in its having 2 pairs of satellited and one pair of secondarily constricted chromosomes. Moreover, proportionate reduction in total chromatin length and mean length are also observed. But for few minor differences, the karyotypes of the two show resemblance in great many respects indicating their closer affinity and early divergence of S. villosum subsp. puniceum from the type species S. villosum subsp. villosum. These 2 tetraploid populations can be considered primitive in comparison to local tetraploid species. (Pl. 4:4).

Between the 2 exotic hexaploid species the karyotype of S. scabrum be considered advance over S. chenopodioides in showing diversities in the types of chromosomes, less pairs with nearly median centromeres and abrupt gradation of the idiogram (Pl. 4:5).

A comparison of all the hexaploid populations reveals the resemblance among themselves. However, minute structural differences do indicate the specific distinction of these taxa.

Although a few other genera of the Solanaceae have been reported to have accessory chromosomes, very little is known about the occurrence of these in the members of the genus Solanum. Rai (1959) has reported the presence of accentric fragments in somatic plates of S. melongena var. insanum.

Thereafter Chennaveeraiah and Krishnappa (1969) have reported the presence of accessory chromosomes in 6 South Indian species of Solanum. Interestingly all these were observed in diploid species only. In the present study, occurrence of accessory chromosomes is observed in some populations of tetraploid and hexaploid taxa belonging to S. nigrum complex. Tetraploid taxa represented by coll.no. 31 of S. villosum subsp. villosum, coll. nos. 11 and 47 of S. purpureilineatum show the presence of 2 or 3 accessory chromosomes. Of the hexaploid taxa S. chenopodioides and S. nigrum represented by coll. nos. 33 and 30 respectively, 2 to 4 B-chromosomes are seen in their somatic complements.

All the indigenous and exotic species of Solanum (i.e. spinescent, 10 species and one form) having different ploidy levels, analysed in the present study can be arranged in the following evolutionary sequence (Pl.4:6).

1. S. trilobatum
2. S. heterodoxum
3. S. viarum
4. S. americanum
5. S. nigrum (diploid)
6. S. nodiflorum
7. S. villosum subsp. villosum
8. S. villosum subsp. puniceum
9. S. purpureilineatum

Pl. 4:6 Histograms of different taxa of family Solanaceae (absolute length of the haploid set of chromosome complement).

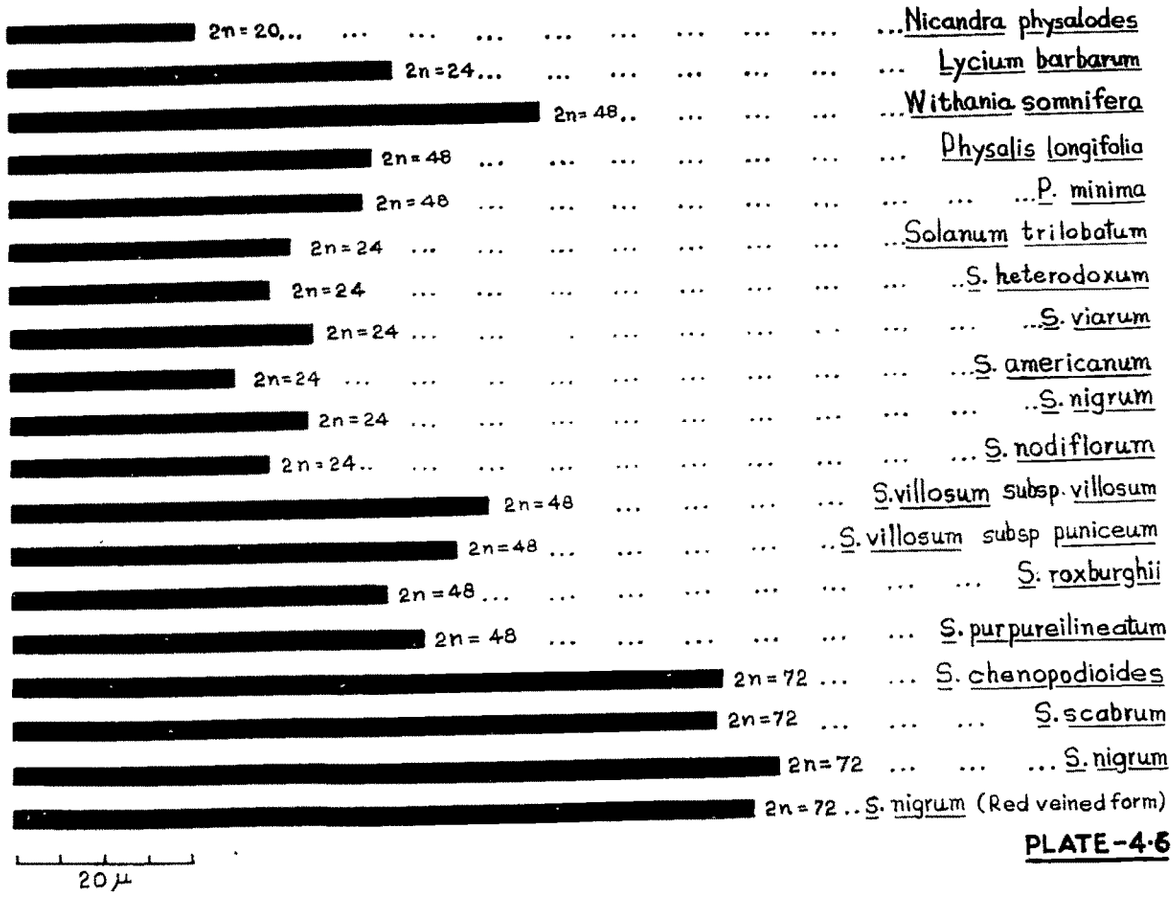

2n = 20 ... Nicandra physalodes
2n = 24 ... Lycium barbarum
2n = 48 ... Withania somnifera
2n = 48 ... Physalis longifolia
2n = 48 ... P. minima
2n = 24 ... Solanum trilobatum
2n = 24 ... S. heterodoxum
2n = 24 ... S. viarum
2n = 24 ... S. americanum
2n = 24 ... S. nigrum
2n = 24 ... S. nodiflorum
2n = 48 ... S. villosum subsp. villosum
2n = 48 ... S. villosum subsp puniceum
2n = 48 ... S. roxburghii
2n = 48 ... S. purpureilineatum
2n = 72 ... S. chenopodioides
2n = 72 ... S. scabrum
2n = 72 ... S. nigrum
2n = 72 ... S. nigrum (Red veined form)
20 μ

PLATE-4·6

10. S. roxburghii
11. S. chenopodioides
12. S. scabrum
13. S. nigrum (hexaploid)
14. S. nigrum (red veined form)

In the foregoing discussion an attempt is made to evaluate the selected taxa of the family on the basis of cytological studies and to understand the existing inter-relationship among them. These are now discussed in the light of known classifications for the family Solanaceae.

In various systems of classification, the proposed positions of the 5 genera, included in the present study, are different and at times these are placed in different suborders, tribes or subtribes. Based on the present study of the karyotypes of these genera they can be arranged in the following evolutionary sequence i.e. Nicandra, Lycium, Withania, Physalis and Solanum. The same sequence regarding the placement of genera into tribes and subtribes is observed in Wettstein's treatment.

In Hooker's flora, C. B. Clarke (1885) has placed genus Nicandra at the end, while the advance genus Solanum is placed first in the suborder Solaneae. The genus Lycium, which appears to be comparatively primitive like Nicandra is placed in a distinct suborder Atropeae next to the suborder Solaneae. While, in Baehni's (1946) treatment, he has placed

genera Solanum and Withania in subtribe Solaninae, Physalis in subtribe Physalidinae of tribe Solaneae. Genus Lycium is positioned in subtribe Atropinae of tribe Atropeae and Nicandra in subtribe Nicandreae of tribe Nicotianeae. Hunziker (1979) has placed genera Solanum, Physalis and Withania in tribe Solaneae; Lycium in tribe Lycieae and Nicandra in Nicandreae in subfamily Solanoideae.

In all these treatments karyotypically primitive genera like Nicandra and Lycium are placed after the karyotypically advanced genera Withania, Physalis and Solanum. D' Arcy (1974) in his treatment has placed all the genera in one subfamily Solanoideae. In his treatment primitive genera like Nicandra and Lycium kept first are followed by Physalis, Solanum and Withania.

Wettstein (1895) and D' Arcy's (1975) treatments are more phylogenetic, where evolutionary status of genera is well defined. Present findings are in agreement with them.

Of all the genera belonging to family Solanaceae, genus Solanum has been studied most extensively. Various workers, from time to time, have classified the genus Solanum into sections, subsections, subgenera etc. Dunal (1852) had divided the genus into 2 sections, Pachystemonum and Leptostemonum having 5 and 3 subsections respectively. Wettstein (1895) on the other hand, divided the same into 5 sections viz., Pachystemonum, Lycianthes, Leptostemonum,

Lycopersicum and Nycterium, of which section Pachystemonum was further divided into 2 subsections viz., Tuberarium and Morella, while, Heigi (1907) in his treatment of the genus Solanum proposed 2 subgenera, Eusolanum and Leptostemonum. The former subgenus, Euslolanum is further divided into 5 sections. Siethe (1962) based on the study of hair types revised the earlier treatments.She has divided the genus into 3 subgenera; Solanum, Archaesolanum and Stellatipilum which were further divided into number of sections and subsections. D' Arcy (1972, 1974) in his study of the genus, has classified it into 2 subgenera, of which subgenus Solanum is further classified into a number of sections. The taxa belonging to S. nigrum complex, included in the present study, based on their karyotypes, fit into section Pachystemonum of Wettstein (1895); subsection Morella of section Pachystemonum of Dunal (1852); section Morella of subgenus Eusolanum (Heigi, 1907); subgenus Solanum, section Solanum of Seithe (1962) and D' Arcy (1974). However, the spine bearing species are placed in section Leptostemonum by these workers.

Inclusion of the species of S. nigrum complex in subsection Solanum is suggested by workers like Seithe (1962) and D' Arcy (1974). The observation of gross resemblance in the karyotypes of these taxa also confirms their inclusion in one subsection. In contrast to this morphologically distinct spine bearing species have been placed in subsection

Leptostemonum by these workers. The karyotypes of these spine bearing species do show distinctness of their karyotypes when compared with the karyotypes of species belonging to the complex. Therefore, their inclusion in a different section is justified by the present karyotypic study.

Nannfeldt (1938), Löve (1951, 1964 a, b), Magoon et al. (1962), Chennaveeraiah & Patil (1968), Tandon & Rao (1974) have suggested that different ploidy series observed in the taxa of S. nigrum complex ought to be given due weightage while classifying the same. The present finding of different ploidy levels in populations of the species analysed also calls for a similar consideration.

F A B A C E A E

Table 4:1. Comparison of the somatic chromosomes of the investigated taxa of the family Solanaceae.

Taxa	Somatic number 2n	Chromosomes with stated type of centromere: nsm	Chromosomes with stated type of centromere: nm	Chromosomes with sec. consts. on long arm	Chromosomes with satellites	Isochromosome	TF %	L/S ratio	Absolute length in μ
Nicandra physalodes Coll. No. 8	20	F_{10}, [illegible]$_2$ — 12	D_2, G_4 — 6	$F_2^{S'}$ — [illegible]	-	Ic_2 — 2	37.34	1.51	21.[illegible]21
Lycium barbarum Coll. No. 15	24	A_8, C_4, F_8 — 20	B_4 — 4	-	C_2^S — 2	-	31.75	1.76	43.190
Withania somnifera Coll. No. 14	48	C_4, F_{24}, H_{10} — 38	B_2, D_8 — 10	-	F_2^S, H_2^S — 4	-	34.46	1.92	59.776
Physalis minima Coll. No. 42	48	F_4, H_{24} — 28	G_{20} — 20	$F_2^{S'}$, $H_2^{S'}$ — 4	H_6^S — 6	-	36.36	2.18	39.951
P. longifolia Coll. No. 41	48	F_{10}, H_{26} — 36	D_2, G_{10} — 12	-	G_2^S, H_8^S — 10	-	32.31	2.70	40.707

Table 4:1. (Contd.) Comparison of the somatic chromosomes of the investigated spinacoum species of the genus Solanum.

Taxa	Somatic number 2n	Chromosomes with stated type of centromere		Chromosomes with sec. consts. on long arm	Chromosomes with satellites	TF %	L/S ratio	Absolute length in μ
		nsm	nm					
Solanum trilobatum Coll. No. 48	24	A_2 F_{10} 12	B_2 D_{10} 12	$L^{S'}_2$ 2	D^{S}_2 2	36.06	1.98	31.856
S. heterodoxum Coll. No. 34	24	C_4 F_8 H_4 16	D_8 3	-	D^{S}_2 F^{S}_2 4	35.37	2.29	29.544
S. viarum Coll. No. 25	24	C_{12} F_8 20	D_4 4	$C^{S'}_2$ 2	C^{S}_2 2	34.32	1.60	34.095

Table 4:1 (Contd.) Comparison of the somatic chromosomes of the investigated species of Solanum nigrum Complex.

Taxa	Somatic number 2n	Chromosome with stated type of centromere			Chromosomes with sec. consts. on long arm	Chromosomes with satellites	TF %	L/S ratio	Absolute length in μ
		nsm	SM	nm					
Solanum americanum Coll. No. 35	24	F_8 H_6 14	-	L_8 G_2 10	-	F_4^S G_2^S 6	36.67	1.35	25.176
S. nigrum Coll. No. 02	24	C_{10} F_6 16	-	D_6 G_2 8	$C_2^{S'}$ 2	C_2^S 2	35.51	2.18	33.367
S. nodiflorum Coll. No. 26	24	F_{18} H_4 22	-	D_2 2	-	F_2^S 2	32.12	2.19	28.548
S. villosum subsp.villosum Coll. No. 31	48+2B	C_8 F_{26} H_6 40	-	D_6 G_2 8	-	F_4^S 4	34.03	2.12	58.685
S.villosum subsp.puriceum Coll. No. 32	48	F_{24} H_{10} 34	-	D_6 G_8 14	$F_2^{S'}$ 2	F_2^S H_2^S 4	35.50	2.08	49.677
S.purpureilineatum Coll. No. 11	48+3B	F_{16} H_{22} 38	-	D_2 G_8 10	$F_2^{S'}$ 2	F_2^S 2	33.00	1.97	46.054
S. roxburghii Coll. No. 18	48	F_{12} H_{30} 42	E_2 2	G_4 4	$E_2^{S'}$ 2	H_2^S 2	32.73	2.43	43.459

Table 4:1 (Contd.) Comparison of the somatic chromosomes of the investigated species of Solanum nigrum Complex.

Taxa	Somatic number 2n	Chromosomes with stated type of centromere			Chromosomes with sec. consts. on long arm	Chromosomes with satellites	TF %	L/S ratio	Absolute length in μ
		nsm	SM	nm					
Solanum chenopodioides Coll. No. 33	72+4B	C_2 F_{28} H_{12} } 42	-	D_{20} G_{10} } 30	-	D^{Sat}_2 H^{Sat}_4 } 6	35.96	2.02	78.906
S. scabrum Coll. No. 36	72	C_4 F_{24} H_{22} } 50	E_2 } 2	B_2 D_8 G_{10} } 20	-	G^{Sat}_2 H^{Sat}_4 } 6	35.14	2.70	78.320
S. nigrum Coll. No. 19	72	C_{16} F_{28} H_2 } 46	-	B_8 D_{18} } 26	C^{Sat}_2 } 2	F^{Sat}_2 H^{Sat}_2 } 4	37.06	2.01	99.527
S. nigrum (Red veined form) Coll. No. 04	72	C_6 F_{28} H_{16} } 50	-	D_{20} G_2 } 22	C^{Sat}_2 } 2	F^{Sat}_2 } 2	35.08	2.18	82.690

Based on the study of different taxa, workers from time to time have reported several base numbers ranging from 4 to 90 for the family Fabaceae. Prominent among them are Wanscher (1934), Senn (1938), Atchison (1951), Frahm-Leliveld (1953, 1957), Turner (1956), Turner & Fearing (1959), Shibata (1962 b), Bir & Sidhu (1967) and Bandel (1974).

Atchison (1951) has suggested the two base numbers X = 10 and 11. Turner and Fearing (1959) supported these base numbers. Moreover, they reported other base numbers, X = 5, 6, 7 & 8. Bandel (1974), while commenting upon "Chromosome numbers and evolution in Leguminosae" has remarked that X = 8 is the most frequent number metwith in 27.75%, while the next frequent numbers are X = 11 and X = 7 found 14.73% and 11.56% of the taxa respectively.

In the present investigation 11 species of Tephrosia and Psoralea corylifolia of the family Fabaceae have been studied. Among these 8 species of Tephrosia have 2n = 22 while the remaining 3 species of Tephrosia and Psoralea corylifolia have 2n = 24 in their somatic complements. These observations therefore, support the earlier suggestion of considering X = 11 and 12 as the base numbers for the family.

For the members of tribe Galegeae, Atchison (1951) and Turner & Fearing (1959) based on their studies have suggested two base numbers X = 10 and 11. However, in the present study base numbers 11 and 12 are observed. This therefore, is in

agreement with the earlier contention of considering X = 11 for the tribe.

In majority of the earlier studies by Kedhar Nath (1950), Ramanathan (1950, 1955), Frahm-Leliveld (1953, 1957), Tandon & Malik (1961), Miege (1960), Venkateswarlu & Kameswara Rao (1963), Bir & Sidhu (1967), Bhatt (1974), Sanjappa & Bhatt (1976), Singh, Raina & Joshi (1976), Krishnappa & Basavaraj (1978) and Shastri (1979) 2n = 22 and n = 11 are the reported numbers for the species of Tephrosia. In 8 species of Tephrosia 2n = 22 and n = 11 while in remaining 3 species viz., T. purpurea, T. wallichii and T. hamiltonii and Psoralea corylifolia 2n = 24 and n = 12 are encountered. Based on the present study as well as the previous studies of Ramanathan (1950, 1955) Frahm-Leliveld (1953, 1957), Tandon & Malik (1961), Miege (1962), Bir & Sidhu (1967), Sanjappa & Bhatt (1976), Krishnappa & Basavaraj (1978) etc. it is suggested that the genus Tephrosia is dibasic and have X = 11 and 12, base numbers from which different species might have originated. Among the species of both the groups (i.e. X = 11 and X = 12) evolution of the karyotypes is evident, which further supports the dibasic nature of the genus Tephrosia.

Kreuter (1930) and Bakele & Sharma (1979) have reported 2n = 20 & 2n = 22 for the species of Psoralea studied. In contrast to this 2n = 24 are reported by Raghavan (1959). In the present study also in the somatic complement of

Psoralea corylifolia 2n = 24 are encountered. Earlier suggested base numbers for the genus are X = 10, 11, & 12. In the present study X = 12 is supported.

As mentioned earlier, taking into consideration the suggestion of Levitsky (1931) and Stebbins (1950), all the 12 taxa investigated (11 species of Tephrosia, Psoralea corylifolia) revealed the presence of asymmetrical karyotypes and therefore, both the genera should be considered advanced ones. The degree of asymmetry varies in different species depending upon the types of chromosomes, L/S ratio and TF%.

The detailed analysis of the karyotypes of different species reveals, that there exists an everall similarity in the general pattern of chromosome morphology and this validitates the inclusion of all the species analysed, in the genus Tephrosia. The complements have chromosomes with nearly median and nearly submedian centromeres except T. wallichii, which has one pair of submedian chromosomes. The species of Tephrosia studied can conveniently be grouped into 2, one having 2n = 22 and second 2n = 24. Among the species with 2n = 22, simple leaved T. strigosa and T. jamnagarensis exhibit less advance nature of the karyotypes than others. Between the two, T. strigosa is more primitive because the complement has 5 pairs of chromosomes with nearly median centromeres. Moreover, lesser value of L/S ratio i.e. 1.64 also indicates the less

asymmetrical nature of the karyotype. In contrast to this T. jamnagarensis has only 4 pairs with nearly median centromeres, higher value of L/S ratio i.e. 2.24 and the presence of one pair of satellited chromosomes in its complement. Between the two, the advance nature of T. jamnagarensis is further proved by the presence of 2-B chromosomes. T. villosa and T. pumila, other 2 species of this group, have 3 pairs with nearly median and 8 pairs with nearly submedian centromeres. Moreover, both the species share the common characters of having a pair of satellited and a pair of secondarily constricted chromosomes. Slightly more advance nature of the karyotype of T. pumila is indicated by L/S ratio (1.90). Comparatively more advanced species T. uniflora subsp. petrosa and T. subtriflora can be placed in between T. pumila and T. candida. T. uniflora subsp. petrosa has 2 pairs of chromosomes with nearly median and 9 pairs with nearly submedian centromeres. While, T. subtriflora has one pair with nearly median and 10 pairs of chromosomes with nearly submedian centromeres in their somatic complements respectively. More evolved nature of T. subtriflora can be seen in its having both secondarily constricted as well as satellited chromosome pairs and also in having higher value of L/S ratio. Amongst the species of this group, T. candida can be considered most highly evolved in the group, for its complement has all the chromosomes with nearly submedian centromeres. Presence of 2 pairs of

secondarily constricted chromosomes, comparatively lesser value of absolute length (26.254 μ) and higher value of L/S ratio (2.14) also indicate the advance nature of the species. Based on this analysis 5 species of this group can be arranged in the following evolutionary sequence : (Table 4:2) (Pls. 4:7 & 4:8).

Tephrosia villosa

T. pumila

T. uniflora subsp. petrosa

T. subtriflora

T. candida

In the second group of 3 species i.e. of T. purpurea, T. wallichii and T. hamiltonii, all have 2n = 24 chromosomes in their somatic complements. Among these species, the karyotype of T. purpurea appears more primitive because it has 5 pairs with nearly median centromeres. Next in the sequence comes T. wallichii which has only 2 pairs of chromosomes with nearly median centromeres. The complements of both the species share the common features of having one pair of satellited, one pair of secondarily constricted chromosomes and having identical values of L/S ratio i.e. 1.75. Moreover, abrupt gradation observed in the idiogram of T. wallichii indicates its advance nature over T. purpurea, which shows comparatively less abrupt idiogram. The karyotype of T. hamiltonii has 2 pairs of nearly median and remaining 10 pairs with nearly submedian centromeres. Between T. hamiltonii and T. wallichii; although both have equal

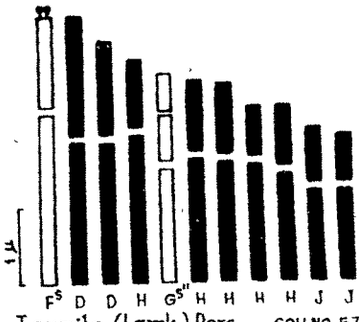
Pl. 4:7 Comparison of idiograms of 10 species of the genus Tephrosia and Psoralea corylifolia.

1. T. strigosa
2. T. jamnagarensis
3. T. villosa
4. T. pumila
5. T. uniflora subsp. petrosa
6. T. subtriflora

Contd...

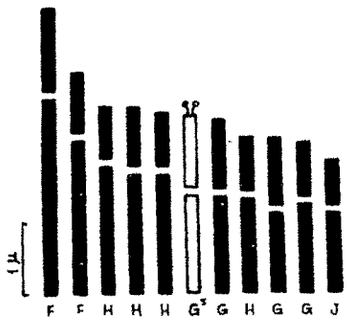
Tephrosia strigosa Dalz. COLL.NO 63

1



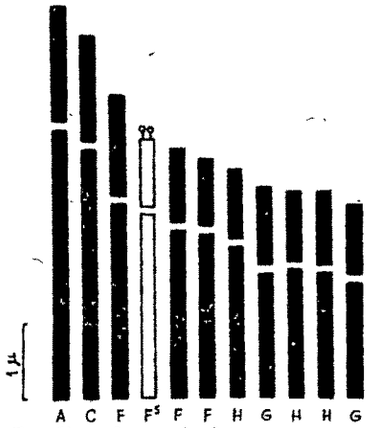
T. pumila (Lamk.) Pers COLL NO. 57

4



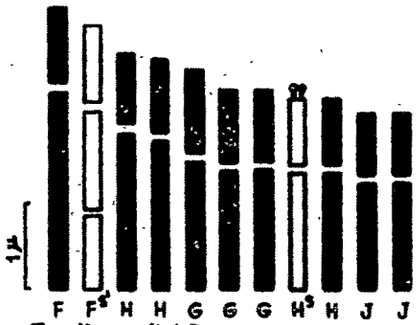
T jamnagarensis Santapau COLL NO. 64

2



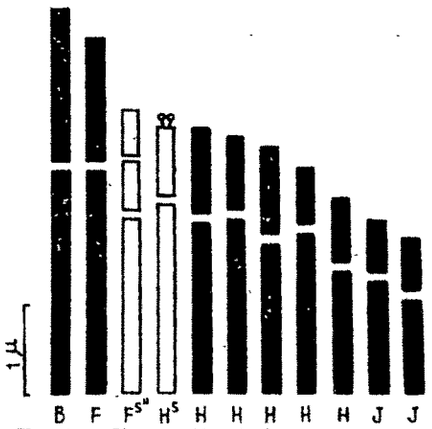
T. uniflora Pers. subsp Petrosa COLL NO 65
Blatt. & Hall.

5



T. villosa (L.) Pers. COLL. NO. 52

3



T. subtriflora Hochst. COLL. NO. 66

6

PLATE - 4:7

Pl. 4:8 (Contd.)

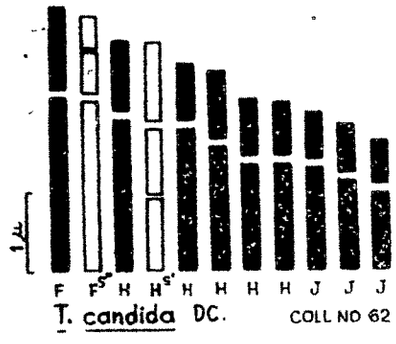
7. T. candida

8. T. purpurea

9. T. wallichii

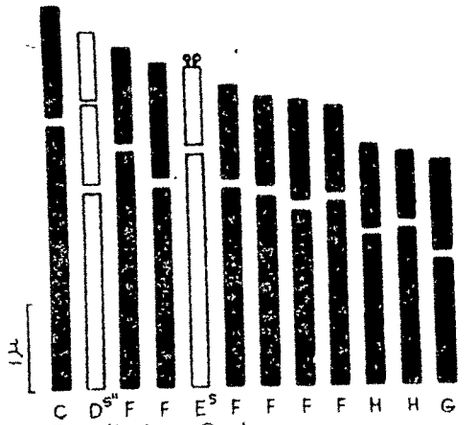
10. T. hamiltonii

Psoralea corylifolia



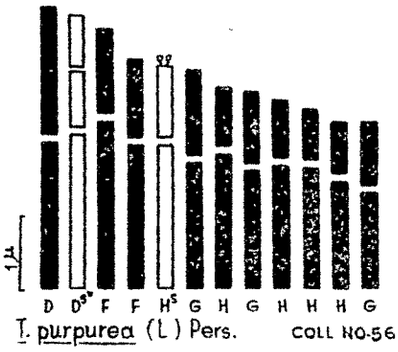
T. candida DC. COLL NO 62

7



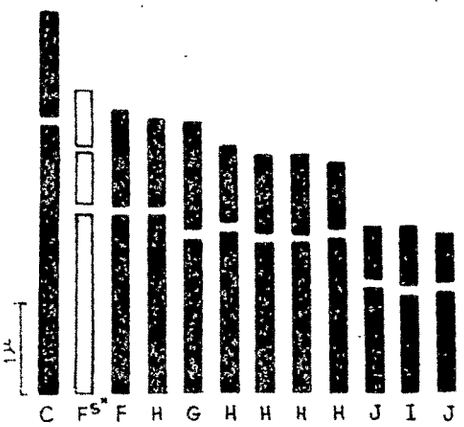
T. wallichii Grahm COLL NO 68

9



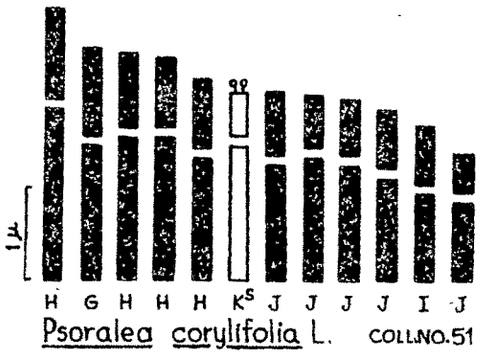
T. purpurea (L) Pers. COLL NO-56

8



T. hamiltonii Drumm. COLL NO.58

10



Psoralea corylifolia L. COLL.NO.51

PLATE - 4:8

pairs of chromosomes with nearly median centromeres, T. hamiltonii can be considered more advanced because of its having higher value of L/S ratio, lesser amount of total chromatin length i.e. 31.837 μ. Idiogram of the T. hamiltonii also shows more abrupt nature of the gradation. Three species of this group can be placed in the following evolutionary sequence : (Table 4:2)(Pl. 4:8).

T. purpurea

T. wallichii

T. hamiltonii

Among the species of both the groups B-chromosomes are observed only in some populations and are not of universal occurrence, in any taxa analysed. Therefore, the B-chromosomes are not taken into consideration for deciding the evolutionary status of the species studied (Plate 4.9).

Baker in Flora of British India (1876) has divided the genus Tephrosia into 3 subgenera on the basis of well defined morphological characters and habit of the plant. Following his treatment, 11 species of Tephrosia included in the present study can be grouped as follows :

Genus : Tephrosia

Subgenus : Macronyx (Dalzell)

Tephrosia strigosa

* T. jamnagarensis

Pl. 4:9 Histograms of different species of Tephrosia and Psoralea corylifolia (absolute length of haploid set of chromosome complement).

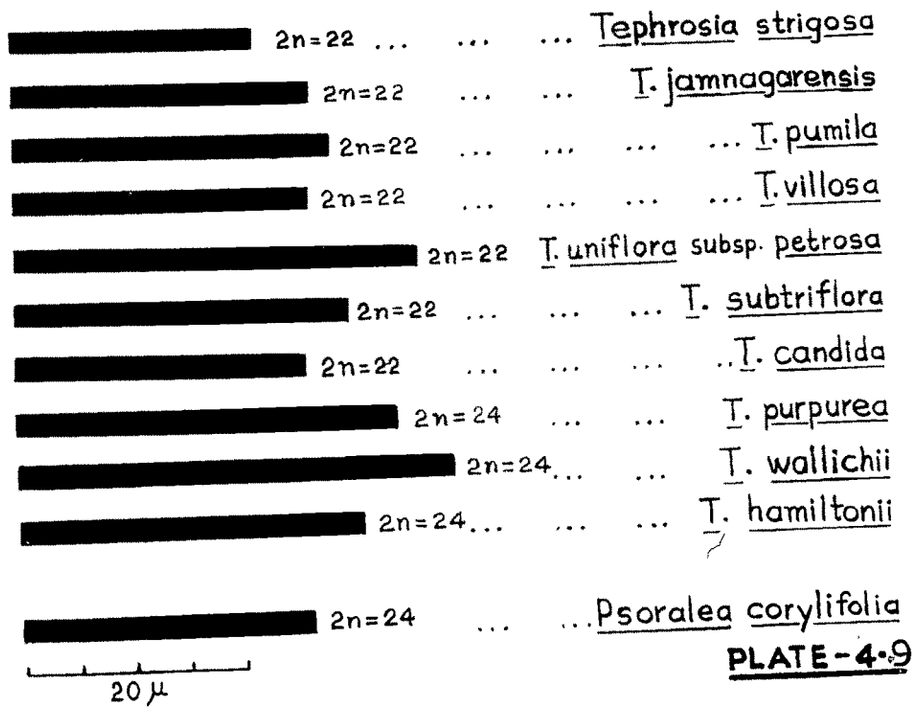

2n=22 ... ... Tephrosia strigosa
2n=22 ... ... T. jamnagarensis
2n=22 ... ... T. pumila
2n=22 ... ... T. villosa
2n=22 T. uniflora subsp. petrosa
2n=22 ... ... T. subtriflora
2n=22 ... ...T. candida
2n=24 ... ... T. purpurea
2n=24 ... ... T. wallichii
2n=24 ... ... T. hamiltonii
2n=24 ... ...Psoralea corylifolia
20 μ

PLATE-4·9

Subgenus : Brissonia (Neck)

T. candida

Subgenus : Reineria (Moench)

T. purpurea

T. villosa

T. uniflora subsp. petrosa

* T. hamiltonii

* T. pumila

* T. subtriflora

* T. wallichii

* T. falciformis

In the present work, an attempt is made to have a fresh look at the Baker's treatment of the genus in the light of cytological findings. Baker's placement of the subgenus Macronyx is justified because T. strigosa and T. jamnagarensis of the group with 2n = 22, have comparatively primitive nature of karyotypes. T. candida included in the subgenus Brissonia exhibit the most advanced nature of karyotype among the taxa having 2n = 22. Therefore, the placement of subgenus Brissonia in 2nd position is not supported by the present study. Majority of the taxa investigated belong to subgenus Reineria placed last. The subgenus Reineria includes taxa having 2n = 22 and 2n = 24. Therefore, it is suggested that taxa having 2n = 22 may be kept distinct from those having 2n = 24. This is suggested

* Not included in Baker's treatment.

because in both the groups definite and distinct evolutionary trends are observed.

There exists a stray report of occurrence of polyploidy in Tephrosia purpurea (L.) Pers. by Tandon & Malik (1961). However, in other works, as well as in the present investigation, polyploidy is not encountered in any of the taxa. Different populations of a species analysed showed great uniformity of number, while minor structural differences are observed in different species. This suggests that the speciation within the genus is due to structural alterations accompanied by aneuploid loss or gain.

The gross resemblance in the karyotypes of the two genera indicate their closeness. However, structural differences of the karyotypes are distinctive enough to suggest the distinctiveness of the two genera and their placement in separate tribes Tephrosieae and Psoralieae as suggested by Hutchinson (1967).

Table 4:2. Comparison of the somatic chromosomes of the investigated taxa of Fabaceae

Taxa	Somatic number 2n	Chromosomes with stated type of centromere			Chromosomes with sec. consts. on		Chromosomes with satellites	TF %	L/S ratio	Absolute length in μ
		lsm	SM	nm	Long arm	Short arm				
Tephrosia strigosa Coll. No. 63	22	H_8 J_4 12	-	G_6 I_1 10	-	-	-	35.62	1.64	22.246
T. jamnagarensis Coll. No. 64	22+2B	F_4 H_8 J_2 14	-	G_8 8	-	-	G_2^S 2	35.29	2.24	27.503
T. villosa Coll. No. 52	22+2B	F_2 H_{10} J_4 16	-	G_6 6	$F_2^{S'}$ 2	-	H_2^S 2	34.30	1.66	27.030
T. pumila Coll. No. 57	22	F_2 H_{10} J_4 16	-	D_4 G_2 6		$G_2^{S''}$ 2	F_2^S 2	37.19	1.90	29.185
T. uniflora subsp. petrosa Coll. No. 65.	22	A_2 C_2 F_8 H_6 18	-	G_4 4	-	-	F_2^S 2	32.24	2.07	37.018
T. subtriflora Coll. No. 66	22	F_4 H_{12} J_4 20	-	B_2 2	-	$F_2^{S''}$ 2	H_2^S 2	33.84	2.57	30.622
T. candida Coll. No. 62	22	F_4 H_{12} J_6 22	-	-	$H_2^{S'}$ 2	$F_2^{S''}$ 2	-	33.10	2.14	26.254

Table 4.2 (Contd.) Comparison of the somatic chromosomes of the investigated taxa of Fabaceae.

Taxa	Somatic number 2n	Chromosomes with stated type of centromere: nsm	SM	nm	Chromosomes with sec. constrictions on: Long arm	Short arm	Chromosomes with satellites	Th %	L/S ratio	Absolute length in μ
Tephrosia purpurea Coll. No. 56	24	F_4 H_{10} 14	-	D_4 G_6 10	-	$D_2^{s''}$ 2	H_2^s 2	36.54	1.75	34.327
T. wallichii Coll. No. 68	24	C_2 F_{12} H_4 18	E_2 2	D_2 G_2 4	-	$D_2^{s''}$ 2	E_2^s 2	33.56	1.75	39.449
T. hamiltonii Coll. No. 58	24	C_2 F_4 H_{10} J_4 20	-	G_2 I_2 4	-	$F_2^{s''}$ 2	-	34.23	2.51	31.837
Psoralea corylifolia Coll. No. 07	24	H_8 J_{10} 18	K_2 2	G_2 I_2 4	-	-	K_2^s 2	34.50	2.20	24.677

DISCUSSION BASED ON MICROMORPHOLOGICAL OBSERVATIONS

S O L A N A C E A E

For better understanding and elucidation of taxonomic and phylogenetic relationships of the taxa selected, quantitative and qualitative data pertaining to micro-morphological characters, such as epidermis, trichomes, stomata and venation pattern, were collected. The taxonomic significance of the data is discussed with a view to assessing the importance of these micromorphological characters (both quantitative and qualitative) at various levels of classification.

All the 5 genera studied were clothed with trichomes. But, for the genus Withania, all the rest were covered by eglandular uniseriate trichomes accompanied by one or the other type of glandular trichomes. As regards the stomatal types, anomocytic, paracytic, anisocytic and stomata with single subsidiary cell have been observed on both surfaces of leaf in majority of the members studied. However, the percentage distribution of these types do differ in each species. Festooned brochidodromous type of venation pattern, representing a modified pinnate camptodromous venation, is observed in members of the 5 genera investigated. Presence of above mentioned common micromorphological features in taxa studied justifies their inclusion in the family Solanaceae.

A scrutiny of the data showed, that certain features are observed in more than one genus. But, at the same time,

other distinctive features are present which distinguish them from one another.

Epidermal cells appear more or less identical in all the five genera. However, the nature of anticlinal walls is different. In Lycium and Withania, the walls are straight and arched, while in other genera they are sinuous. The sinuousites in Solanum and Nicandra are prominent and well defined, while in Physalis they are not well defined and at places give way to straight walls.

In addition to the common type, other types of trichomes if present in different genera are very specific. The genus Lycium is characterised in having only simple uniseriate, filiform trichomes, while Withania is distinct by itself in its having branched candelabra type and stellate type of trichomes. The remaining 3 genera viz., Nicandra, Physalis and Solanum, have in addition to common type, long uniseriate stalked trichome with unicellular glandular head. The genus Nicandra also revealed the occasional occurrence of short stalked trichomes with multicellular capitate head, which are absent in other two genera.

Though all the 4 types of stomata are found to be present in different genera studied, the remarkable difference is observed as regards to their percentage distribution. Anisocytic type is predominant in Nicandra and Solanum, which shows more than 50% representation in Solanum species and

less than 50% in Nicandra. In contrast to this anomocytic stomata are predominant in Physalis and Lycium represented by more than 50%. The genus Withania differs from the rest in having predominance of paracytic type of stomata. Except Lycium, in the remaining 4 genera, stomata with single subsidiary cell are recorded. This type when present is usually represented by 10% or less.

More or less uniform nature of basic venation pattern is observed in all the genera studied. However, differences encountered do serve some useful purpose in delimiting the genera. The genus Lycium is distinct from the other genera in showing complete absence of intersecondaries. Nicandra and Lycium also share a common feature of not having bundle sheath jacketing the veins and veinlets. The remaining 3 genera viz., Physalis, Solanum and Withania have veins of all degrees jacketed by parenchymatous bundle sheath. Minor venation details showed the occurrence of loops within the areoles in majority of the members of the genus Solanum. Areoles are smaller sized (0.33 mm^2) in Withania with thick veinlets, while in 2 spp. of Physalis areole size ranges in between 0.5-1 mm^2 with thin veinlets. Primitive genus Nicandra and advanced genus Solanum share the common feature of loop formation within the areoles.

Nicandra physalodes resembles two species of Physalis in having conical uniseriate and long uniseriate stalked with

unicellular head type of trichomes. It also showed resemblance to Withania somnifera, Physalis longifolia & P. minima and Solanum scabrum, S. roxburghii, S. purpureilineatum, S. nodiflorum, S. nigrum (Red veined leaf form) and type species S. nigrum in having intersecondary veins in the intercostal regions. Resemblance of Lycium barbarum in its having simple uniseriate filiform type of trichomes to Solanum roxburghii & S. purpureilineatum, is noticed. This species also resembles 2 species of Physalis studied in showing higher percentage and predominance of anomocytic type of stomata. Two species of Solanum viz., S. heterodoxum and S. villosum subsp. villosum differ from other species of Solanum investigated, in showing the sinuous course of secondary veins. However, closely related S. villosum subsp. puniceum differs from the type species in having straight course of secondary veins. Though morphologically closely related S. villosum subsp. villosum and S. villosum subsp. puniceum share the common character of having unicellular and long uniseriate stalked with unicelled head types of trichomes but the variety differs from the type species S. villosum subsp. villosum, in its having straight course of secondaries. Among the Solanum species studied, S. purpureilineatum, S. nodiflorum, S. chenopodioides, S. americanum, and S. trilobatum showed vein order of higher degree i.e. 6° and the same was recorded for Physalis longifolia. Of the two closely related species S. purpureilineatum & S. nodiflorum, isolated vein ending lying free

in the areoles were noticed only in the former one. S. trilobatum is specific in its having only eglandular stellate type of trichomes while the S. chenopodioides is distinct in showing the presence of extension cells and uniseriate trachied within areoles and complete absence of stellate type of trichomes. S. americanum is characterised in possessing long uniseriate stalked with glandular unicellular head type of trichome along with a few scattered stellate type trichomes.

The above mentioned 3 species can as well be differentiated from one another on the basis of stomatal types present therein. In all the 3 species a predominance of anisocytic type of stomata is seen. All the four types viz., anomocytic, paracytic, anisocytic and stomata with single subsidiary cell in S. chenopodioides, 3 types viz., anomocytic, paracytic and anisocytic in S. trilobatum, and only 2 types i.e. anomocytic and anisocytic in S. americanum are observed. Of the 13 species and 1 form of Solanum remaining S. villosum subsp. villosum, S. villosum subsp. puniceum, S. scabrum, S. roxburghii, S. nigrum (Red veined form), type species S. nigrum, S. viarum, and S. heterodoxum showed highest vein order upto 5°. S. nigrum type species, is distinct in its having fimbriate nature of marginal vein. S. nigrum and its variety viz., S. nigrum (Red veined form), S. americanum and S. scabrum share a common feature of their

having eglandular stellate and glandular long uniseriate stalked with unicelled head types of trichomes. While S. viarum and S. roxburghii revealed the complete absence of stellate hairs.

FABACEAE

In the present investigation 11 species of Tephrosia and Psoralea corylifolia are included. Members of both the genera viz., Tephrosia and Psoralea resemble each other in micromorphological features. Epidermal cells of polygonal or quadrangular shapes having straight anticlinal walls are observed. Leaf or leaflet surfaces are thickly or sparsely clothed with trichomes of one type only i.e. eglandular unicellular ones. In both the genera predominance of paracytic type of stomata is observed and percentage of the same is always more than 50. Pinnate camptodromous venation pattern is modified to form brochidodromous type in all taxa of Fabaceae studied.

2 genera viz., Tephrosia and Psoralea can be easily distinguished from each other on the basis of definite grouping of certain features. All the members of genus Tephrosia reveal the presence of 3 types of stomata viz., anomocytic, paracytic and anisocytic; a number of composite intersecondaries in the intercostal regions and mostly rectangular areoles. While Psoralea corylifolia has 2 types of stomata, paracytic and anomocytic, one or few interseconda-ries and variously shaped areoles.

The members of Fabaceae studied revealed great uniformity in number of microanatomical features such as epidermal cells,

trichomes, stomatal types, and basic venation pattern. Therefore, these features can not be used profitably for specific distinction. The data concerning details of venation pattern was not known to exist for the family. The quantitative data pertaining to this aspect collected for the taxa studied, serves some useful purpose of grouping the related taxa.

Two broad groups, based on highest degree of vein order are distinguishable. One group having 4° as the highest vein order includes T. strigosa, T. jamnagarensis, T. subtriflora, T. wallichii, T. candida, T. pumila. Among these taxa T. strigosa and T. jamnagarensis are distinct in having simple leaves and showing more number of secondaries on either side of the midvein (18-30), higher number of veinlets per unit area in areoles (30-35), and smaller size of the areole (0.2 mm^2) characteristics of the minor venation pattern. Remaining 4 species T. subtriflora, T. wallichii, T. candida, T. pumila with compound leaves have less number of secondaries and veinlets but larger sized (0.5 mm^2) areoles. The other distinguishing feature of the venation pattern, is the presence of bundle sheath, jacketing veins of all degrees.

The second group having 5° as the highest vein order includes T. uniflora, T. villosa, T. falciformis, T. purpurea, T. hamiltonii. Among these taxa, type species T. purpurea and allied taxa T. hamiltonii resembled in having less number of veinlets in areoles per mm^2 (15-18) and comparatively median

sized areole (between 0.25 - 0.33 mm^2). The remaining 3 species of the group viz., T. uniflora, T. villosa and T. falciformis have more number of veinlets (24-32) in areoles per unit area and smaller sized areoles i.e. 0.2 mm^2 to 0.25 mm^2. The grouping of T. purpurea & T. hamiltonii is also supported by the presence of bundle sheath. The data concerning the number of secondaries, on either side of the midvein, for different taxa showed overlapping, hence do not support the above grouping of taxa.

The taxonomic significance of micromorphological characters has been emphasized by a number of workers from time to time. The present study of selected taxa of Solanaceae and Fabaceae also supports the above mentioned contention. However, the more specific qualitative characters are few and these, to a greater extent, only help in delimiting the taxa of generic levels. Some specific qualitative characters could be profitably used for specific distinction of some members of Solanaceae but same is not true for the members of Fabaceae. The quantitative data, pertaining to epidermal cells, stomata and venation pattern collected for different species, indicate the importance of such values for specific distinction. The present study supports the views of Levin (1929), Hall & Melville (1951, 1954), Gupta (1961) and others, that the absolute veinislet area and absolute vein termination number are nearly constant for a species, which

can be used as a valuable specific criteria. Similarly stomatal types, a weak taxonomic feature, when considered along with frequency, percentage, size, index etc. can be used for taxonomic evaluation.

It is evident from the above discussion that micro-morphological data, both qualitative and quantitative on many occasions do not help in delimiting the taxa at various levels of classification.