CHAPTER I

INTRODUCTION

INTRODUCTION

SOLANACEAE

Family Solanaceae embraces 84 genera and about 3,000 species (D' Arcy, 1979) of diversified habits. One or the other member of this family occur on every vegetated continent of the world. The earliest reference to the members of the family is in a book named 'Dioscorides Codex' published in A. D. 815. The family is also reputed for many alkaloid yielding plants and so the relevant citation of some of them are also seen in ancient literature.

From the time of Linnaeus various groupings of the genera, now belonging to Solanaceae,have been attempted. But it was Jussieu, who for the first time grouped all the known genera and recognised the family Solanaceae in 1789. Since then, a number of workers dealing with the family have proposed different schemes for ordering the genera within the family. These schemes reflect generic and intergeneric relationships among the taxa included therein. As many as 12 different schemes dealing with the classification of the family have been proposed by Brown, R. (1810), Humboldt, Bonplandt & Kunth (1818), Nees von Esenbeck (1837), Don, G. (1838), Endlicher, Meisner (1839-41), Miers, J. (1846-49), Dunal, M. F. (1852), Bentham, G. (1876), Wettstein, R. von (1895), Baehni, C. (1946), D' Arcy, W. G. (1974) and Hunziker, A. T. (1979).

Among these, Bentham's treatment (1876) in 'Genera Plantarum' and Wettstein's in 'Die Naturlichen Pflanzenfamlien' attracted greater attention. But for Hegnauer (1973) majority of the workers consider Wettstein's treatment to be more natural, phylogenetic and exhibiting evolutionary trends.

Bentham (1876) in 'Genera Plantarum' and C. B. Clarke (1885) in Hooker's flora have placed the genus Solanum first and genus Nicandra last in the tribe (= suborder) Solaneae while the genus Lycium is placed in a distinct tribe Atropeae, placed next to the tribe Solaneae.

Following Bentham's treatment Baehni (1946) in his revision divided the family into six tribes which are further divided into subtribes. Solanum and Withania occupy first and second position respectively in subtribe Solaninae and Physalis is in subtribe Physalidinae of the tribe Solaneae. Like Bentham, distinctness of the genus Lycium is also accepted by him by placing it in tribe Atropeae. But in his treatment tribe Atropeae is further divided into 3 subtribes and genus Lycium is placed in subtribe Atropinae. Hutchinson (1969) also considers the tribe Atropeae to be a basic and natural one. Genus Nicandra in Baehni's treatment is also placed downward in subtribe Nicandreae.

On the other hand in Wettstein's treatment (1895) the family is divided into five distinct tribes. Considering the

genus Nicandra to be primitive and distinct, it was placed in tribe and subtribe Nicandreae occupying first position while the remaining 4 genera are kept in tribe Solaneae wherein genus Lycium is kept in subtribe Lyciinae and Withania, Physalis and Solanum in subtribe Solaninae.

Recently D' Arcy (1974, 1975) and Hunziker (1979) while introducing certain fundamental modifications in the earlier system of Wettstein (1895), have taken into consideration the data accumulated in last 80 years, concerning seed morphology, embryology, palynology, karyomorphology etc. D' Arcy (1975) recognises 3 subfamilies : Solanoideae, Cestroideae and Nolanoideae in the family Solanaceae. While Hunziker (1979) recognises 2 viz., Solanoideae and Cestroideae and considers Nolanaceae (= Nolanoideae) as a distinct family. All the genera mentioned above are included in the subfamily Solanoideae in both the schemes. Hunziker (1979) has further divided the subfamily into 7 tribes. Probably considering genus Solanum to be the type-genus,for the family and subfamily,tribe Solaneae is kept first. Genera Solanum, Physalis and Withania are kept in the tribe Solaneae. Tribes Lycieae and Nicandreae, containing genera Lycium and Nicandra occupy 4th and 5th positions respectively. However, recent palynological (Basak, 1967) embryological (Soueges, 1907; Crete, 1959), seed development (Prasad & Dalbir Singh, 1978) and cytological (Darlington & Janaki Ammal, 1945; Sinha, 1951) studies clearly indicate the

primitive nature of the genus Nicandra.

It is quite obvious from the foregoing account that there is no unanimity among researchers regarding the placement of genera and their inclusions in specific tribes or subtribes depicting their evolutionary status (Table I).

Of the 5 genera, Lycium and Solanum have been further classified. Wettstein (1895) created 3 sections Bachycope, Mesocope and Macrocope of the genus Lycium. As early as 1852, Dunal divided the genus Solanum into 2 sections; Pachystemonum containing 5 subsections and Leptostemonum containing 3 subsections. Wettstein (1895) created 5 sections within the genus. In 20th century Haegi (1907), Seithe (1962) and D' Arcy (1974) in their works have modified the earlier treatments of the genus. Haegi (1907) divided the genus into 2 subgenera, Eusolanum with 5 sections and Leptostemonum without any further section. Seithe (1962) based on study of hair types and their development recognised 6 subgenera; Solanum, Lycopersicum, Bassovia, Archaesolanum, Lyciosolanum and Stellatipilum containing sections and subsections.

Bessis & Guyot (1979) based on their study of stomatal types of 56 species of the family, have observed stomatal heterogeneity in different recognised tribes of Solanaceae and also substantiate Wettstein's classification in recognition of 2 series.

Positions of selected taxa of the Solanaceae in different schemes of classifications.

Bentham (1876)	Wettstein (1895)	Baehni (1946)	D' Arcy (1975)	Hunziker (1979)
Order - Solanaceae	Family - Solanaceae	Family - Solanaceae	Family - Solanaceae	Family - Solanaceae
Suborder - Solaneae	Tribe- Nicandreae	Tribe- Solaneae	Subfamily-Solanoideae	Subfamily-Solanoideae
Solanum	Subtribe-Nicandreae	Subtribe-Solaninae	*Lycium*	Tribe - Solaneae
Physalis	*Nicandra*	*Solanum*	*Nicandra*	*Solanum*
Withania	Tribe- Solaneae	*Withania*	*Physalis*	*Physalis*
Nicandra	Subtribe-Lycinae	Subtribe-Sarchinae	*Solanum*	Tribe - Datureae
	Lycium	.....	*Withania*	.....
Suborder- Atropeae	Subtribe-Hyoscyminae	Subtribe-Margarithinae	Subfamily-Cestroideae	Tribe - Jaboroseae
Lycium	.....	.....	.....	.....
Suborder- Hyoscyamae	Subtribe-Solaninae	Subtribe-Physalidinae	Subfamily-Nolanoideae	Tribe - Lycieae
.....	*Withania*	*Physalis*	.....	*Lycium*
Suborder- Cestrineae	*Physalis*	Subtribe-Iochrominae		Tribe - Nicandreae
.....	*Solanum*	.....		*Nicandra*
	Tribe - Datureae	Tribe - Atropeae		Tribe - Solandreae
	.....	Subtribe-Atropinae		.....
	.....	*Lycium*		Tribe - Juanulloeae
	Tribe - Cestreae	Subtribe-Markeinae		.....
	Subtribe-Cestrinae	.....		Subfamily-Cestroideae
	.....	Subtribe-Hyoscyaminae		Tribe - Cestreae
	-Goetzeinae	.....		.....
	.....	Tribe - Nicotianeae		Tribe - Nicotianeae
	-Nicotianinae	Subtribe-Datureae		.....
	.....	.....		Tribe - Schwenckieae
	Tribe-Salpiglossideae	Subtribe-Nicandreae		.....
		Nicandra		Tribe - Parabouchetieae
		Tribe - Nicotianeae		.....
		Subtribe-Nicotianinae		Tribe - Salpiglossideae
		.....		
		Tribe - Anthocercideae		
		.....		
		Tribe - Salpiglossidae		
		.....		

D' Arcy (1974), based on his treatment on the "Solanum species of Florida" created 2 subgenera, Solanum and Potatoe. The former subgenus contains as many as 14 sections.

Certain taxa of the genus Solanum have been the subject of extensive studies for obvious reasons. Solanum nigrum, popularly known as black, common or garden nightshade, because of its universal occurrence and polymorphism has attracted the attention of many. And the same is reclassified and reconstituted by different workers from time to time. However, the placement of the taxa belonging to Solanum nigrum complex is always in section or subsection Morella (= Maurella) in different treatments.

Considering the Solanum nigrum as the generic type species D' Arcy (1974) changed the name of section Morella to Solanum and kept it at the beginning. This change is as per the recommendation of the International Code (Seithe, 1979).

In recent times, as a result of extensive studies by Nakamura (1937), Stebbins & Paddock (1949), Soria & Heiser (1961, 1962), Heiser, Soria & Burton (1965), Henderson (1974), Al-Nowaihi & Khalifa (1974), Schilling & Heiser (1976) and Heiser, Burton & Schilling (1979) of the populations of the complex occurring in different parts of the world, have resulted in bringing forth a fact that the complex embraces a number of distinct species showing slight morphological

variations accompanied by genetic isolation. These species constitute a series of diploids (n=12), tetraploids (n=24) and hexaploids (n=36).

It is now quite evident from the works of eminent workers like Stebbins & Paddok (1949), Heiser et al. (1965, 1976, 1979), Edmonds (1972, 1977, 1979) etc. that highly variable species, namely Solanum nigrum, is composed of a number of distinct taxa, which can be considered as good species or infraspecific races.

Both Edmonds (1979) and Hunziker (1979) have stressed the need of more experimental work for better resolution of the existing, confused taxonomic delimitations of the recognized species of the complex. However, Hunziker places no less emphasis on the data obtained through classical techniques of morphology, anatomy, embryology and cytology for better elucidation of the problem.

Amongst the indian workers Bhaduri (1933) was the first to report the existence of 3 different ploidy levels in populations of S. nigrum. Subsequent workers like Swaminathan (1949), Sharma & Bal (1961), Magoon et al. (1962), Rao (1965, 1979), Tandon & Rao (1964, 1966, 1974), Chennaveeraiah & Patil (1968), Rao, Khan & Khan (1978, 1979) and Venkateswarlu & Rao (1972) in their works have also reported the occurrence of different ploidy levels among the populations

of S. nigrum complex. In the works of Magoon, Ramanujam & Cooper (1962), Tandon & Rao (1964, 1966, 1974) and Chennaveeraiah & Patil (1968) have strongly recommended to confer separate specific status on the diploid and tetraploid forms and retaining the binomial S. nigrum for the hexaploid form. However, in none of these works distinctness of the species included in S. nigrum complex, is well spelt out.

The distinctness of the species, now included in S. nigrum complex, at times becomes difficult due to overlapping morphological characters. The possibility that most of the recognised species of the complex are the result of natural hybridization between different related species or infra-specific taxa. May be, because of inbreeding among themselves, many populations represent 'species in making' which have developed only partial isolating mechanisms and not the complete genetic isolations. Bhatt (1971 unpub.) following the computer based key of Heiser et al. (1965) recognized the existence of 4 distinct species belonging to S. nigrum complex of Gujarat. Because of the above mentioned facts, it becomes important that the populations of this complex representing morphologically distinct species of Gujarat region be studied. With a view to gather more information of S. nigrum complex of Gujarat. A few recognized phylogenetically related exotic species of the complex, are also included in the present study.

Other genera included in the present study are Nicandra, Lycium, Withania and Physalis. A perusal of literature reveals that for the members belonging to these genera, either only chromosome number are reported or in few cases preliminary karyotype studies are made. Janaki-Ammal (1932), Darlington & Janaki-Ammal (1945), Sinha (1951) have studied genus Nicandra, Chromosome number reports for the genus Lycium are by Malik (1960) and Baquar et al. (1965, 1966), Chromosome counts for species of Physalis are by Menzel (1951) and Baquar et al. (1965, 1966) and for Withania somnifera by Bhaduri (1933), Miege (1960) and Mohan Ram & Kamini (1964).

It is quite evident from the review of the literature concerning the members of this family, that no attempt has been made by any one, to study these different genera collectively. The present study of these genera, therefore was undertaken to get a comprehensive and comparative cytological and micro-morphological data, which would help in better understanding of the evolutionary status of these genera and mode of speciation followed by them.

Metcalfe & Chalk (1950) studied the trichomes in various families of the order Polemoniales. Thereafter, many genera of the polemoniales and Solanaceae in particular have been studied from their ontogenic point of view by many researchers. Prominent among them are Goodspeed (1954), Seithe (1962), Ahmad (1964 a, b), Chandra (1967), Inamdar (1967, 1968),

Roe (1967), Inamdar & Patel (1973) and Ramakrishna & Razi (1977).

Initially only 3 types of stomata were recorded for the family Solanaceae by Metcalfe & Chalk (1950). Subsequently Seithe (1962), Ahmad (1964 a, b), Chandra (1967) reported some abnormal types along with the normal ones. Inamdar & Patel (1969), Patel & Inamdar (1971 a, b) have reported the occurrence of 2 additional types of stomata, paracytic and transitional type between diacytic and paracytic along with several other abnormalities not reported hitherto. Recently Ramakrishna & Razi (1977) in their studies of 15 species of Solanum confirmed the earlier reports of stomatal types and abnormalities.

Von Ettinghausen initiated the study of leaf architecture in 1861. Thereafter prominent workers like Solereder (1908), Levin (1929), Foster (1950, 1952) and Stace (1965 a, b; 1969 a, b; 1973) etc. studied the leaf architecture in scattered group of angiosperms. Only recently after Hickey (1973) gave full terminology of the leaf architecture, venation pattern study has attracted the attention of scholars. "Leaves are basically simple, margin entire, venation pattern pinnate camptodromous and secondaries are strongly brochidodromous tending to form intramarginal vein" in the order polemoniales (Hickey & Wolfe, 1975). Coleman & Greyson (1976) reported the presence of

multiseriate fimbriate marginal vein in Tomato. Inamdar & Murthy (1978) based on their study of 12 taxa of Solanaceae confirmed the observations of earlier researchers.

FABACEAE

Family Leguminosae is known to be a vast and natural one comprising of three closely related subfamilies viz., Mimosideae, Caesalpinoideae and Papilionoideae (or Lotoideae as validitated by Rehder, 1945). Jones (1955) considers the family Leguminosae as an order (= Leguminales) containing four families, the above mentioned three and fourth one Krammeriaceae. Among these, the zygomorphic flowered Fabaceae is considered to be advanced and the climax group containing 482 genera and 1200 species. It includes both woody as well as herbaceous genera distributed all over the world (Hutchinson, 1967).

A number of workers have proposed schemes classifying various members of the family. But prominent among them are Bentham & Hooker (1865), Taubert (1891-1894), Rydberg (1928), Dormer (1946), Hutchinson (1967) and Rendle (1975).

Bentham & Hooker (1865) in their treatment have classified various genera of the Fabaceae into categories like tribes and subtribes. Subsequent taxonomists in their schemes, however, followed Bentham & Hooker's treatment as the basis and

introduced certain modifications taking into consideration the newly gathered data. Thereafter, studies by various researchers indicate the need of reinterpreting a large number of anomalies which have crept into the so called envisaged classificatory schemes, proposed. As early as 1946, Dormer had also remarked that "some of the tribes contain genera which are not really closely related to each other". But the criteria which have so far been employed are not adequate, to do the task of redistribution of these genera. This is quite true for a few genera of the family such as Desmodium, Alysicarpus, Galega, Glycine, Tephrosia, Psoralea etc.

As only the species of Tephrosia and Psoralea are included in the present study, systematic position of these two genera in different schemes has been discussed.

Both, in Bentham & Hooker (1865) and Tauberts' (1891-1894) treatments Tephrosia and Psoralea are placed in subtribes Tephrosieae (= Tephrosiinae) and Psoralieae (= Psoraliinae) of the tribe Galegeae. In Bentham & Hooker's treatment subtribe Psoraleiaae (= Psoralinnae) occupies first position while in Taubert's treatment it is placed second in position. Dormer (1946) accepts Taubert's scheme as the basis. But in his proposed scheme, the position of subtribes Tephrosiinae and Psoraliinae are 2nd and 4th respectively in tribe Galegeae. Dormer (1946) also indicated the presence of distichous

phyllotaxy accompanied by interlocking trilacunar insertions in all species of Tephrosia. Even the presence of closely placed parallel nerves which reach the margin and form loops, is a distinctive feature of the genus Tephrosia from allied genera. Hutchinson (1967) considered Fabaceae as one of the family of the order Leguminales. Further in his treatment in order to reduce the number of "exceptions" Hutchinson (1967) raised all the subtribes to the level of tribes. He divided the family Fabaceae into as many as 50 tribes. Genera Tephrosia and Psoralea are placed in tribes Tephrosieae and Psoralieae. Respective position of these tribes is 23rd and 32nd in Hutchinson's (1967) treatment of the family.

A good deal of researches have been carried out for the members of the family Fabaceae. Especially cytological work has been attempted by many researchers. Kreuter (1930), Techechow (1933, 1935), Senn (1938), Delay (1950-51), Atchison (1951), Frahm-Leliveld (1953, 1962), Simmonds (1954), Berger et al. (1958), Turner & Fearing (1959, 1960), Tandon & Malik (1961), Venkateswarlu & Kameswara Rao (1963), Love & Solbrig (1964-65), Bir & Sidhu (1967), Love, Love & Kapoor (1971), Bhatt (1974), Sanjappa & Bhatt (1976), Singh, Raina & Joshi (1976), Sanjappa (1978), Krishnappa & Basavaraj (1978), Bakele & Sharma (1979) and Shastri (1979 - unpub.) are the prominent ones, who have cytologically investigated the taxa belonging

to the family Fabaceae. Turner & Fearing (1959) based on their studies opioned that tribe Galegeae chromosomally represents a heterogenous assemblage of taxa. Atchison (1951) had also suggested shifting of certain taxa from the tribe.

Majority of the studies, cited above, are mere reports of chromosome numbers and their bearing on the phylogeny of the taxa studied. However, in the study of Bhatt (1974), Krishnappa & Basavaraj (1978) and Shastri (1979) karyotypes of some of the species of Tephrosia are described. In the study of Bakele & Sharma (1979) Psoralea corylifolia has been worked out.

Evidences from other disciplines such as anatomy, palynology, embryology etc. differ among themselves thus creating confusion regarding the delimitations of taxa at various levels of classification. Turrill (1954) suggested that help must be sought in synthetic taxonomy, to resolve such confusions. Role of cytology and anatomy is proved beyond doubts, by classical researchers in the respective fields.

The data on the trichome types for tribes of the family (Papilionaceae) were first compiled by Metcalfe & Chalk (1950). Tribe Galegeae is characterised by the presence of eglandular unicellular type of hairs and occasional occurrence of club shaped trichomes with or without distinct stalk.

Recognised variability in the types of stomata (Metcalfe & Chalk, 1950) has also been confirmed by the findings of subsequent scholars; Shah & Gopal (1968, 1969), Shah & Kothari (1973, 1974, 1975, 1976), Shah, Danaiah & Parabia (1973) for the members of the family.

No report of venation pattern study for the members of family is found in the available literature except that "The leaves are basically pinnately compound, margin entire, venation pinnate, secondaries brochidodromous and stipules present" in the order Fabales (Hickey & Wolfe, 1975).

As can be seen from the foregoing brief review of the available literature that there is no unanimity among the researchers regarding the envisaged phylogenetic relationships among the taxa including in the present study. Evidences from other disciplines also differ among themselves, which add to the confusion. Considering the need, for proper understanding of the phylogenic relationships, present study was undertaken.

For proper elucidation of some taxonomically difficult and confused taxa, cytological and anatomical evidences have contributed a lot. Therefore, in the present study morphological, cytological and micromorphological studies of selected taxa have been attempted. Observations obtained from these studies are used to draw conclusions concerning the systematic positions and phylogenetic relationships of these taxa.

The present study is confined to cytological and micromorphological analysis of 18 species belonging to 5 genera i.e. Nicandra, Lycium, Withania, Physalis and Solanum of Solanaceae; and 11 species belonging to genus Tephrosia and Psoralea corylifolia of Fabaceae.

Plan of Study

Present study was planned as follows :-

Collection of populations, belonging to various species. selected, were made from different habitats and localities. Mature seeds were also procured from other parts of India and abroad. Seeds of the collected populations were grown in identical conditions, in Botanical Garden of the M. S. University of Baroda, Baroda. Observed morphological characters are described in details in the chapter of morphological observations.

Mitotic and meiotic study of these populations was done with to decide the base number and also to understand inter-relationships & mode of speciation of the taxa studied. Karyotype data is used for comparison of allied taxa for detecting ecotypes and cytotypes present within the circumscription of a species.

Apparent pollen fertility for each species was determined using Muntzing solution.

Micromorphological study of leaf; pertaining to epidermal cells, stomatal types & frequency, trichomes and details of venation pattern, was done. Based on these observations, quantitative values related to these characters, were also calculated.

Results obtained for the above mentioned aspects are presented in the thesis. The chapter plan of the same is given below :

Materials and Methods : This chapter includes list of materials used, their sources and methods adopted for taxonomical, cytological and micromorphological studies.

Observations : This chapter deals with the following aspects :

Morphological : It includes recent nomenclature, description of individual species and variations observed in different populations.

Cytological : In this part data pertaining to chromosome number, chromosome morphology, meiotic behaviour and pollen fertility are presented. An attempt is also made to compare the same with the earlier available cytological data for the species.

Micromorphological : In this part of observations specieswise brief account of micro-morphological characters of leaf like epidermal cells, trichomes,

stomata and venation pattern, is presented. Based on these observations, calculated numerical values are also included.

Discussion : In this chapter, the bearing of both cytological and micromorphological observations are discussed separately. The cytological data concerning chromosome number, chromosome morphology and meiotic behaviour are used to evaluate evolutionary status, interrelationships and mode of speciation of the taxa studied.

Similarly bearing of micromorphological observations for better elucidation of envisaged interrelationships among the taxa is discussed.

In the last chapter, summary of results and conclusions drawn are presented. An attempt is also made to synthesise the results of the two approaches, while drawing conclusions.

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