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Venation Pattern in the Sepals of Certain Species of Solanaceae and its Contribution to the Taxonomy of the Family

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ABSTRACT

Twenty species and one variety belonging to two subfamilies and six tribes of Solanaceae were selected for an investigation of venation pattern in the sepals as expressed morphologically. The anatomical source and behavior of the three main sepal bundles representing the sepal vascular supply were investigated as well. These two parameters were chosen to test how far they might contribute to the taxonomy of this family. Two venation types were recorded viz. Parallelodromous and pinnate; the latter with seven sub-types. Anatomically, there was a range in the origin (source) and behavior of the main sepal supply. No correlation exists so far between the type of venation and the main sepal vascularization. The studied species were categorized into eight groups according to the venation pattern of the sepals.

Key-Words: Solanaceae; Sepal; Architecture; Venation patterns; Vasculature

INTRODUCTION

Leaf architecture, as defined by Foster (1952), refers to the placement and form of those elements constituting the outward venation pattern, marginal configuration, and leaf shape and gland position. He also added (op.cit) that Ettingshausen as early as 1861, made the first comprehensive effort to systematize the description of the vegetative leaf architecture with his classification of venation patterns. Subsequent publications by botanists and paleobotanists stressed the importance of this parameter in the solution of a number of taxonomic and phylogenetic querries, and different classifications of dicotyledonous leaf architecture were proposed (Lesquereux, 1878; Kerner, 1895; Berry, 1916; Goebel, 1905; Lam, 1925; Hollick, 1936; Troll, 1938; Hickey 1971b, 1973). Recently Jesudass *et al.* (2003) adopted the same objective to investigate the venation pattern in 16 fern species of the genus *Pteris* which proved to be helpful in delimiting distantly related taxa. Inamdar and Murthy (1978) made a reference to the leaf architecture of twelve species of the Solanaceae, they found no correlation between the areole size and the number of vein endings in the leaf. Some evolutionary trends in the angiospermic flowers were also comprehended through the study of the floral organs architecture (Stauffer, 1937; Eames & Daniels, 1947; Hillson, 1959; Kumari, 1982).

Relying on the fact that, of all the floral organs the sepal is the nearest in its morphological and anatomical characters, although minimized, to the vegetative leaf from which it evolved, the present study is conducted to test how far the sepal architecture can contribute to the taxonomy of Solanaceae.

MATERIALS AND METHODS

Mature flower buds of 20 species and one variety of Solanaceae were colleted from different sources (Table I). The material was fixed in F.A.A. For studying the venation of the sepals, clearing was made by soaking the calyces in lactic acid overnight. The cleared material was washed with water, stained with safranin (2%), then placed onto glass slides and investigated by a bright field microscope, photographs and line drawings were presented. For studying the sepal vasculature, serial transverse sections 10-15µ thick of the flower buds were stained with safranin–light green combination according to the customary methods (Johansen, 1940). Drawings were made by the aid of microprojector. Terminology of venation patterns was adopted after Hickey (1973). Where more than a species share the same type of venation or vascularization, only one photograph and/or drawing is laid down to represent all the members sharing this character. The scientific names of the species were those mentioned by Hepper (1998).

RESULTS

Morphology of the calyx. Except in *Capsicum frutescens, Cestrum species, Petunia hybrida and Solanum melongena* with five-six sepals all other species have five- sepaled calyx. The latter is cup-shaped or tubular ending in distinct lobes.

Venation (Plate I, Figs. 1-8). Type I: Parallelodromous in *Datura innoxia* (Figs. 1a,b); in which two or more primary veins are detected at the sepal base and run parallel to the apex.

Table I. Collection data and classification of the studied taxa of Solanaceae (Classification after D'arcy 1991)

Species	Source*
F. Solanaceae	
S.F.I-Cestroideae	
Tribe 1. Cestreae	
1-*Cestrum diurnum* L.	(ii)
2-*C.parqui* L'Her.	(ii)
3-*C.nocturnum* L.	(ii)
Tribe 2. Nicotianeae	
4-*Nicotiana glauca*. R. C. Grah.	(iii)Nd
5-*Petunia hybrida Vilm*.	(ii)
S.F.II-Solanoideae	
Tribe 3.Datureae	
6-*Datura innoxia* Mill.	(iii)Nd
Tribe 4. Hyoscyameae	
7-*Hyoscyamus muticus* L.	(iii)M
Tribe 5. Lycieae	
8-*Lycium europaeum* L.	(iii)Nd,M
Tribe 6. Solaneae	
9-*Capsicum frutescens* L.	(i)
10-*Iochroma cyaneum* M.l.	(ii)
11-*Lycianthes rantonnetti* Bitter	(ii)
12-*Lycopersicum esculentum* Miller	(i)
13-*Physalis peruviana* L.	(i)
14-*Solanum incanum* L.	(iii)Nd
15-*S. jasminoides* Paxt.	(ii)
16-*S.melongena* L.	(i)
17-*S. nigrum* L. var. humile Asch.	(iii)N
18-*S.seaforthianum* And.	(ii)
19-*S.schimperianum* Hochst.	(ii)
20-*S.tuberosum* L.	(i)
21-*Withania somnifera* Dun.	(iii)N,M

(*)Source of material: (i) Species cultivated as edible plants; (ii) species cultivated as ornamentals and colleted from public gardens in Cairo; (iii) wild species (M, the Mediterranean region; N, the Nile region; Nd, the Nile delta region)

Type II: Pinnate with a single primary vein (mid-vein). This type includes the following sub-types

Sub-type (1): Simple craspedodromous in *Iochroma cyaneum* (Fig 2a, b); in which the secondary veins and their branches reach the margin.

Sub-type(2): Semicraspedodromous in *physalis peruviana* (Fig.3a,b), *Lycium europaeum* and *Solanum nigrum* var. *humile;* in which the secondary vein branches at the margin into two, one reaches the margin and the other joins the super-adjacent secondary vein.

Sub-type (3): Intermediate between the simple craspedodromous and semicraspedodromous in *Solanum seaforthianum* (Fig.4a, b), *Nicotiana glauca*, *Petunia hybrida*, *Solanum jasminoides* and *S.melongena*.

Sub-type (4): Camptodromous - Kladodromous in *Hyoscyamus muticus* (Fig.5a, b); in which the secondary veins do not reach the margin but ramify freely towards it.

Sub-type (5): Camptodromous, brochidodromous in *Lycopersicum esculentum* (Fig.6a, b) and *Solanum tuberosum*; in which the secondary veins join together in a series of prominent arches.

Sub-type (6): Eucamptodromous in *Cestrum diurnum* (Fig. 7a, b), *C. parqui* and *C. nocturnum*; in which the secondary veins are similar to those in sub-type (5) but without forming prominent arches.

Sub-type (7): Camptodromous, reticulodromous in *Solanum incanum* (Fig.8a, b), *Capsicum frutescens*, *Lycianthes rantonnetti*, *S. schimperianum* and *Withania somnifera*; in which the secondary veins loose their identity towards the margin by repeated branching into a vein reticulum.

Anatomical source and behaviour of sepal vascular bundles (Plate II, Figs. 1-45). In the present work the sepal vasculature showed the basic number of bundles viz. one median and two laterals. As for the origin (source) and behaviour of these bundles the following cases were recorded:

I-The sepal median arises from the receptacular siphonostele, and then branches to give two lateral bundles. The branching occurs either i) in the receptacular tissue (*Capsicum frutescens*–Figs. 1-3, *Datura innoxia*, *Lycopersicum esculentum*, *Physalis peruviana*, *Solanum schimperianum* and *Withania somnifera*), ii) in the calyx tube (*Solanum melongena*–Figs. 4-9, *Cestrum parqui*, *Solanum incanum* and *S.nigrum* var. *humile*) or iii) in the distinct lobes (*Cestrum diurnum*–Figs. 10-13, and *C. nocturnum*).

II-The sepal median arises from a dissected siphonostele then branches to give two lateral bundles followed by further ramification. The branching occurs either i) in the receptacular tissue (*Solanum seaforthianum* – Figs. 14-16 and *S.tuberosum*) or ii) in the calyx tube (*Lycianthes rantonnetti*–Figs. 17-20 and *Solanum Jasminoides*).

III- The sepal median and the sepal laterals diverge independent from the receptacular siphonostele. The sepal laterals diverge as five masses, each represents two fused laterals, then branch in the receptacular tissue giving a large number of minor bundles (*Nicotiana glauca*–Figs. 21-25), or diverge as ten distinct traces. In the latter case all the ten traces are either derived from the siphonostele (*Lycium europaeum*–Figs. 26-30) or only five derived from the siphonostele and the other five are the result of branching of the sepal medians (*Iochroma cyaneum*–Figs. 31-36).

IV-The sepal median and sepal laterals are derived from two different sources: Source 1-The sepal median diverges from the receptacular siphonostele and the two laterals diverge from a complex which also gives the petal trace (*Petunia hybrida*–Figs. 37-41); Source 2-The sepal median also diverges from the siphonostele, then divides radially giving one sepal lateral. The other sepal lateral comes from a sepal lateral–petal complex by tangential division (*Hyscyamus muticus*–Figs. 42-45). Both the median and laterals undergo further ramification (Fig.45).

DISCUSSION

In the present study, two principal venation types were recorded *viz*. parallelodromous and pinnate. The first type was recorded in one species only (*Datura innoxia*), while

Plate I. (Figs.1-8): Photographs and line drawings (a & b respectively) of sepals of the studied taxa to show venation types. Fig.(1), Parallelodromous (*Datura innoxia*, x6); Fig.(2), Simple craspedododremous (*Iochroma cyaneum*, x7); Fig.(3), Semicraspedodromous (*Physalis peruviana*, x 6); Fig. (4), Intermediate between simple and semicraspedodromous (*Solanum seaforthianum*, x3); Fig.(5), Kladodramous (*Hyoscyamus muticus*, x 6); Fig. (6), Brochidodromous (*Lycopersicum esculentum*, x6); Fig. (7), Eucamptodromous (*Cestrum diurnum*, x14); Fig. (8), Reticulodromous (*Solanum incanum*, x14)

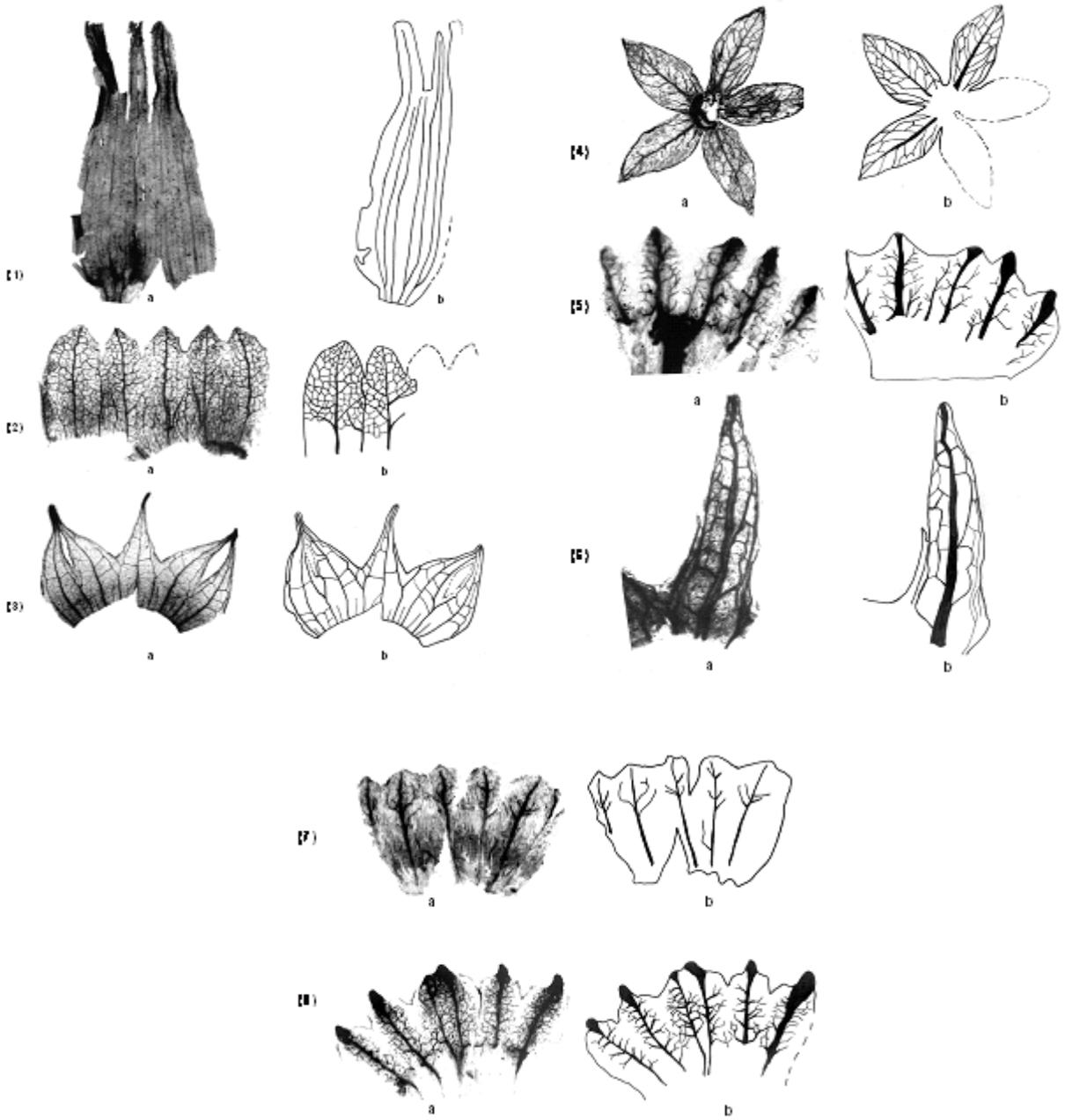
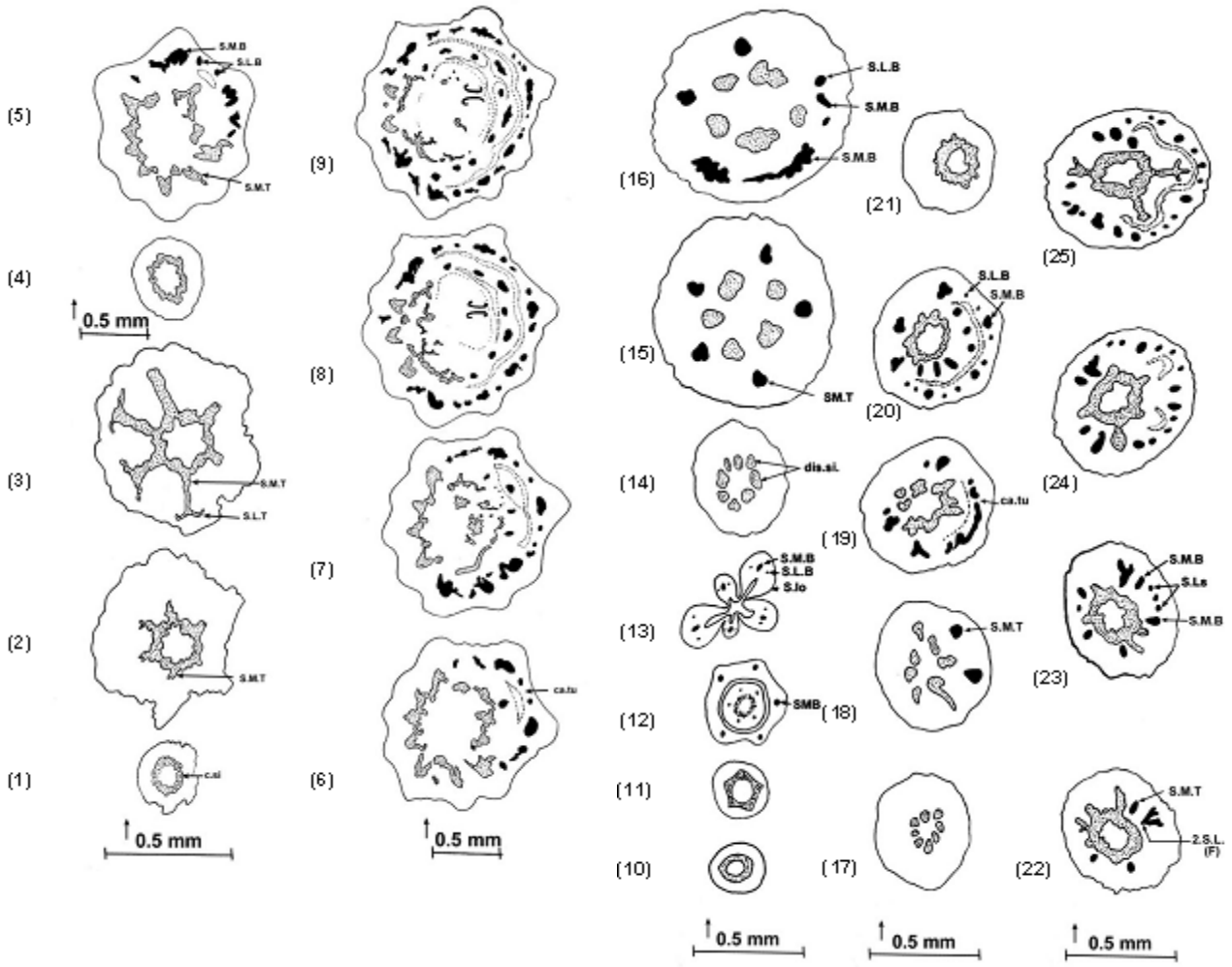
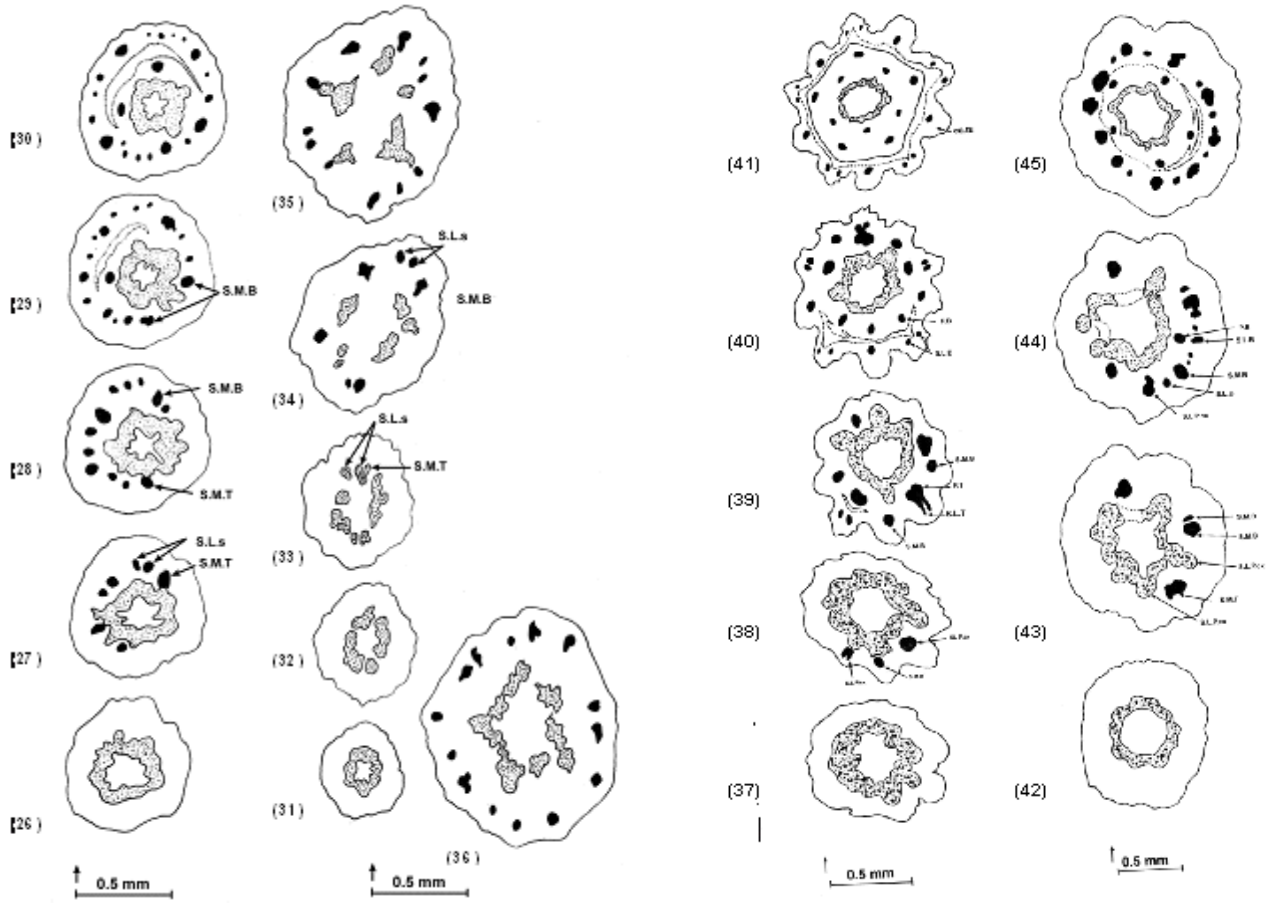


Plate II Figs. (1-45): Serial transverse sections of flower buds from below up to the differentiation of the calyx tube. Figs. (1-3) *Capsicum frutescens*; Figs. (4-9) *Solanum melangena;* Figs. (10-13) *Cestrum diurnum*; Figs. (14-16) *Solanum seaforthianum;* Figs. (17-20) *Lycianthes rantonnetti*; Figs. (21-25) *Nicotiana glauca;* Figs. (26-30) *Lycium europaeum*; Figs. (31-36) *Iochroma cyaneum*; Figs. (37-41) *Petunia hybrida*; Figs. (42-45) *Hyoscyamus muticus*. (ca. tu.= Calyx tube; c.si.= Continuous siphonostele; dis. si= Dissected siphonostele; F.S.Ls= Fused sepal laterals; P.T= Petal trace; S.lo=Sepal lobe; S.Ls= Sepal laterls; S.M.B= Sepal median bundle; S.L.-P.cx= Sepal lateral-petal complex; S.L.T= Sepal lateral trace; S.M.T.= Sepal median trace)



the remainder species (20 species) were found to have a pinnate venation. This latter type was differentiated into seven sub-types. Of all the venation types, the eucamptodromous pattern was recorded in the three studied species of *Cestrum* and hence could be described as consistent at the generic level. As for the other genera there was a range of venation patterns among their species. However, Sprotte (1941), Müller (1944) and Rauh (1951) stated that not only an immense range is found in the venation patterns in angiospermic vegetative leaves but also in the floral organs. Similarly, the anatomical source as well as the behaviour of the primary bundles (sepal median bundle) and the two secondary bundles (sepal laterals) vary in the different species investigated. In case of *Capsicum frutescens*, *Solanum melongena* and *Cestrum diurnum* although the two lateral bundles diverge from the median one yet the level of divergence varies in the three species. In *Capsicum frutescens* it occurs in the receptacular tissue, in *Solanum melongena* it occurs in the calyx tube, and in *Cestrum diurnum* in the distinct calyx lobes. Kumari (1982), in his study on Lamiaceae, stated that the branching is considered to be the simplest when it occurs in the receptacular tissue. An elaborate case is that the branching occurs in the calyx tube and still more elaborate when it occurs in the distinct calyx lobes. Unlike the former cases; the adnation of the sepal and petal traces was recorded in *Petunia hybrida* and *Hyoscyamus muticus* where the sepal laterals diverge from a sepal lateral–petal complex. Eames

Plate II continue



(1929) and Norris (1941) stated that such adnation is a relatively advanced condition. However, the remainder taxa resemble each other in that the sepal bundles have a common source which is the central siphonostele. In this work, however, no correlation exists between the venation pattern as expressed morphologically and the anatomical source and behaviour of the bundles that form it. For this, the studied taxa might be grouped under the following types according to the venation pattern.

Type-I. Venation parallelodromus (in *Datura innoxia*); **Type-II.** Venation pinnate; Sub-type1-Camptodromous, eucamptodromous in *Cestrum parqui*, *C. diurnum* and *C. nocturnum*; Sub-type2-Camptodromous, reticulodromous in *Capsicum frutescens*, *Lycianthes rantonnetti*, *Solanum incanum*, *S. schimperianum* and *Withania somnifera*; Sub-type3-Camptodromous, brochidodromous in *Lycopersicum esculentum* and *Solanum tuberosum;* Sub-type4-Camptodromous, kladodromous in *Hyoscyamus muticus*; Sub-type5-Craspedodromous, simple craspedodromous in *Iochroma cyaneum*; Sub-type6-Craspedodromous, semicraspedodromous in *Lycium europaeum*, *Physalis peruviana* and *Solanum nigrum* var. *humile;* Sup-type7-Intermediate between the simple craspedodromous and the semicraspedodromous in *Nicotiana glauca*, *Petunia hybrida*, *Solanum jusminoides*, *S. melongena,and S. seaforthianum.*

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