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Petal venation in *Trigonella* (papilionaceae)

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Abstract. Petal venation of nine species of *Trigonella* has been worked out. A positive correlation has been found between length or area and the number of dichotomies but no correlation is found with breadth. In all the species corolla is of simple type except *T. polycerata* in which it is of medicagoid type. Among the different types of anastomoses *C* and *D* types are of most frequent occurrence and other types are species specific with a low range of variation.

Keywords. Petal venation ; papilionaceae ; trigonella.

1. Introduction

The analysis of petal venation received the attention of various workers in tracing phylogeny after the remark that petal venation shows both simplicity and diversity. Petal venation of regular corolla received the attention of various workers (Arnott and Tucker 1963, 1964 ; Banerji and Mukherji 1970 ; Banerji 1972) but that of irregular corolla received only the attention of Datta and Saha (1968) and Subramanyam and Nair (1973). Datta and Saha (1968) reported important differences at specific level in types of anastomoses and their pattern of distribution on standard, wing and keel petals of four species (*Butea frondosa*, *Cajanus cajan*, *Dolichos lablab* and *Erythrina indica*) belonging to tribe phaseolae. Hence from the perusal of the literature it appears that venation of petals may be significant at specific level and since no work is available on the species of *Trigonella*, therefore, in this paper petal venation of nine species has been worked out.

2. Materials and methods

Flower buds for the present study were either collected locally or procured from places as mentioned below :—

Species	Place of collection
1. *Trigonella arabica* Dehile	Bet Dagan, Israel.
2. *T. caerulea* Ser.	Ontario, Canada.
3. *T. callicerasoites* Fish	Ontario, Canada.

Species	Place of collection
4. *T. corniculata* Linn.	Meerut, India.
5. *T. cretica* (L.) Boiss.	Ontario, Canada.
6. *T. gracilis,* Benth.	Nainital, India.
7. *T. polycerata,* Linn.	Meerut, India.
8. *T. stellata* Forsk.	Jerusalem, Israel.
9. *T. suavissima* Lindl.	Canberra, Australia.

Petals from fully mature flowers were cleaned in lactic acid, stained in 1% aqueous safranin and mounted in glycerine. Twenty-five petals of each species were studied. Drawing of each petal was subdivided equally into basal, central and peripheral regions. Mean number of dichotomies and anastomoses was calculated in each sector. Area of the petal was measured by planimeter. For describing the types of anastomoses classification of Arnott and Tucker (1963) is mainly followed.

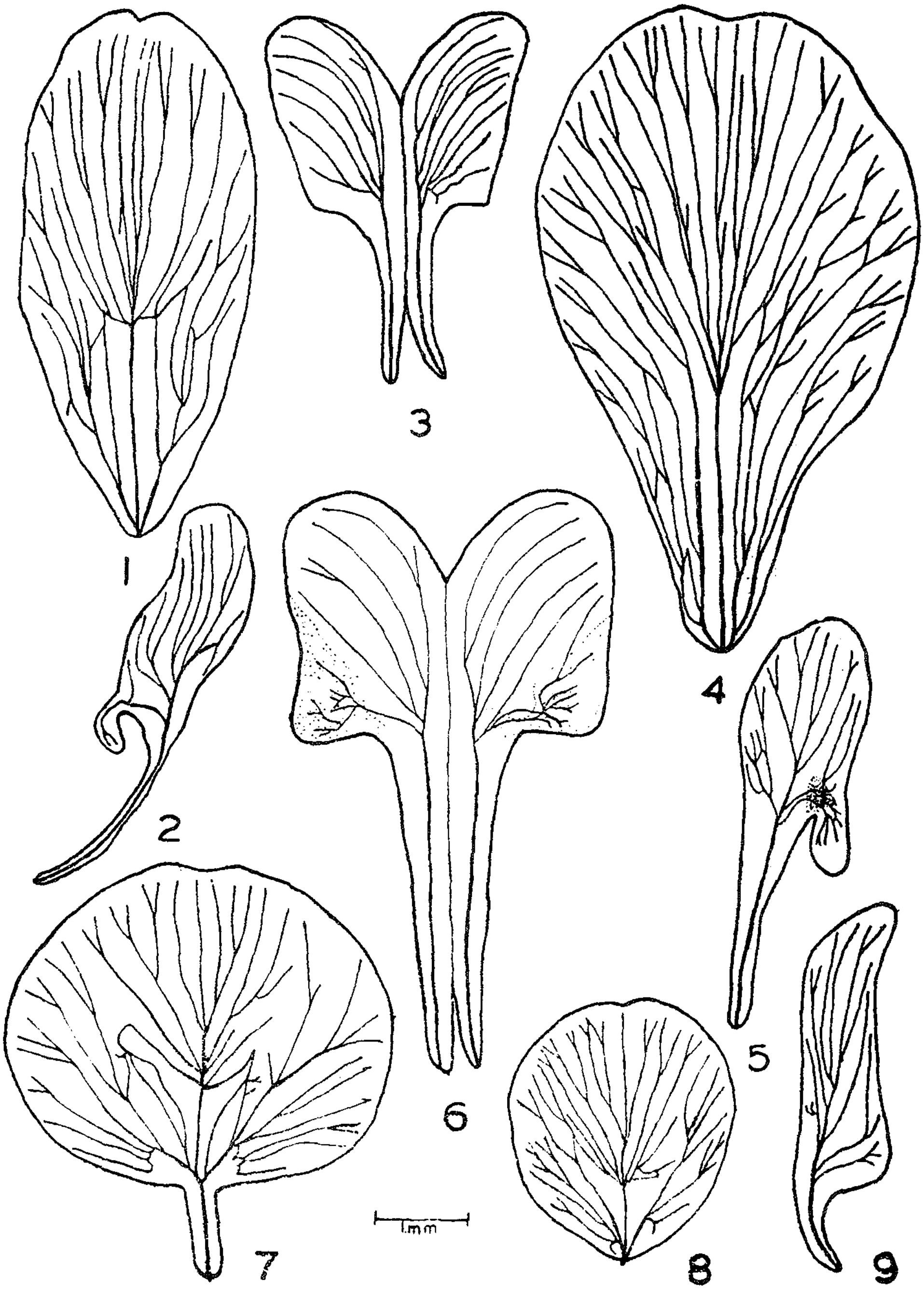
3. Observations

Each flower consists of a standard, two keel and two wing petals which vary in shape, size and structure (figures 1–3). Standard petal is symmetrical while the other petals are asymmetrical. Keel and wing petals are clawed (figures 2–3, 5–6), but standard petal is generally nonclawed except *T. arabica, T. gracilis* (figure 7) and *T. callicerasoites*. Each petal receives a single trace which branches after the separation of the individual petal (figures 1–2).

Standard petal is generally obovate in shape (figure 4) except *T. gracilis, T. cretica* (figure 8) and *T. callicerasoites* in which it is elliptic. Apex is notched in all the species. The bundle that enter the standard petal branches into one median and two costal veins in the basal region (figures 4, 8). However, in *T. gracilis* (figure 7) it branches at the base of the limb. Out of three veins, costal vein branches further dichotomously but the median vein first branches trichotomously and then dichotomously (figures 7–8). However, in few petals of *T. polycerata* median vein shows first dichotomous branching then trichotomous and further dichotomous branching.

The bundle of the keel and wing petals branches dichotomously at the junction of limb and claw (figures 2–3, 5–9). In *T. caerulea* and *T. arabica* wing petals possess ridges and grooves at the distal end and the veins end freely in the groove region. The wing petals of *T. polycerata* (figure 5) and *T. callicerasoites* are serrated at the distal end.

In all the species wing petals at the junction of the limb and claw possess a spur like process which is generally tubular except *T. stellata* and *T. cretica* (figure 9), in which it is flattened. This spur like process receives supply from the main bundle of the petal (figure 3). Wing petal of *T. polycerata* has a tooth like process also at the distal end. This tooth like process is nectariferous and vascular bundles in this region are found to be inversely oriented with respect to the petal. Keel petals of this species has a pocket like structure which receives the tooth like process of the wing petal (figures 5–6). In all the types of petals venation is mainly open dichotomous (figures 1–9).



Figures 1–9. Venation in petals of *Trigonella*. 1–3. standard, keel and wing petals of *T. caerulea*, 4–6. standard, wing and keel petal of *T. polycerata*, 7. standard petal of *T. gracilis*, 8. standard of *T. suavissima*, 9. wing petal of *T. cretica*.

Table 1.

Name of the species/ type of Petal	Mean area in mm^2	Mean length in mm ± SE	Mean breadth in mm ± SE	Mean number of dichotomies ± S E			
				Basal	Central	Peripheral	Total
1. *T. arabica*							
Standard	17·10	5·68± ·19	4·19± ·13	13·60±·65	15·20±1·15	14·6 ± ·53	44·62±1·07
Wing	6·06	5·53± ·12	1·64± ·33	5·00± ·95	10·60±1·04	5·40± ·45	21·00±1·02
Keel	4·87	5·24± ·28	1·81± ·03	2·00± ·69	13·00±1·22	2·60±0·60	14·00±1·96
2. *T. callicerasoites*							
Standard	14·89	5·27± ·27	4·21± ·19	11·6 ± ·89	11·8 ±1·36	9·6 ± ·60	33·0 ±1·19
Wing	6·25	5·87± ·43	1·59± ·33	1·40± ·88	15·6 ± ·92	5·4 ± ·21	26·4 ±1·94
Keel	6·68	6·41±1·24	1·88± ·65	3·0 ±1·28	11·8 ± ·99	0·8 ± ·25	15·6 ±0·91
3. *T. caerulea*							
Standard	8·90	4·69± ·42	2·49± ·11	7·0 ±1·02	15·0 ± ·92	3·2 ± ·65	25·2 ±1·34
Wing	2·00	4·40± ·39	0·87± ·04	0	9·2 ± ·18	1·4 ± ·11	10·6 ±0·60
Keel	2·63	4·04± ·21	1·24± ·08	0	8·8 ± ·78	1·0 ± ·06	8·9 ±0·77
4. *T. corniculata*							
Standard	15·88	6·41± ·35	4·16± ·32	14·8 ± ·83	8·2 ±1·12	3·6 ± ·59	25·2 ±1·90
Wing	6·81	5·98± ·30	1·84± ·07	4·6 ± ·96	11·2 ±1·17	2·2 ± ·28	18·0 ±1·01
Keel	8·50	6·63± ·27	2·09± ·008	5·57± ·74	7·75±1·19	0	13·50± ·43
5. *T. cretica*							
Standard	6·83	3·64± ·22	2·72± ·10	12·80± ·65	9·60±2·0	2·2 ± ·52	26·6 ±2·26
Wing	2·31	3·81± ·25	0·97± ·04	4·00±1·04	5·00± ·98	1·0 ± ·06	10·0 ±1·31
Keel	2·72	3·72± ·11	1·21± ·02	3·00±0·62	7·20± ·59	0·40± ·31	10·60± ·45

6. *T. gracilis*							
Standard	10·98	4·36± ·11	4·05± ·04	14·00± ·57	18·00± ·36	12·08± ·06	44·06± ·38
Wing	2·91	3·31+ ·41	1·35+ ·03	2·75+ ·03	13·25+ ·73	4·25+ ·41	20·25+ ·42
Keel	2·57	3·47+ ·36	1·36+ ·52	0	12·00± ·04	0	12·00± ·04
7. *T. polycerata*							
Standard	16·24	6·97± ·24	3·84± ·20	10·81±1·21	27·20±2·16	21·20±1·08	61·20±2·36
Wing	3·37	4·87± ·16	1·34± ·04	0	17·20±1·80	5·80±0·19	23·00±1·76
Keel	3·06	4·78± ·35	1·31± ·21	0	8·40±0·60	2·00±0·39	10·80±0·59
8. *T. stellata*							
Standard	7·50	4·25± ·03	2·69± ·07	9·40± ·78	14·00±1·33	4·40± ·59	27·40±1·04
Wing	2·25	3·97± ·07	1·07± ·06	0·60± ·28	10·60±0·45	2·00± ·48	13·20± ·59
Keel	2·03	3·37± ·25	1·15± ·01	0	8·60± ·78	0·80± ·24	9·40± ·45
9. *T. suavissima*							
Standard	5·92	3·54± ·40	2·40± ·06	9·0 ±1·58	17·00±1·34	15·50±1·57	41·50±2·02
Wing	2·16	3·58± ·22	0·97± ·03	4·20±1·04	10·40±1·29	3·40±0·35	18·40±2·29
Keel	2·30	3·30+ ·02	1·14+ ·03	0·20+0·16	10·40+0·91	1·80+0·29	12·40+2·34

3.1. *Dichotomies*

Table 1 shows mean area, mean length and mean breadth of the different types of petals and mean number of dichotomies in different regions with standard error. A positive correlation has been found in all the species except *T. caerulea*, *T. corniculata* and *T. callicerasoites* between area and number of dichotomies (figure 10). Similarly a positive correlation of dichotomies is also found with length except *T. corniculata*, *T. gracilis* and *T. suavissima* (figure 11). No correlation is found with breadth (figure 12).

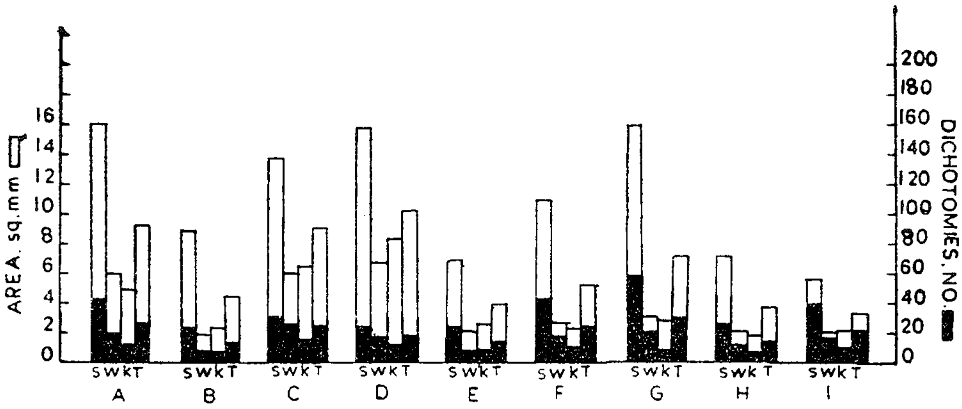


Figure 10. Histogram comparing the average area with mean number of dichotomies of standard (s), wing (w), keel (k) and total corolla (T) in different species.

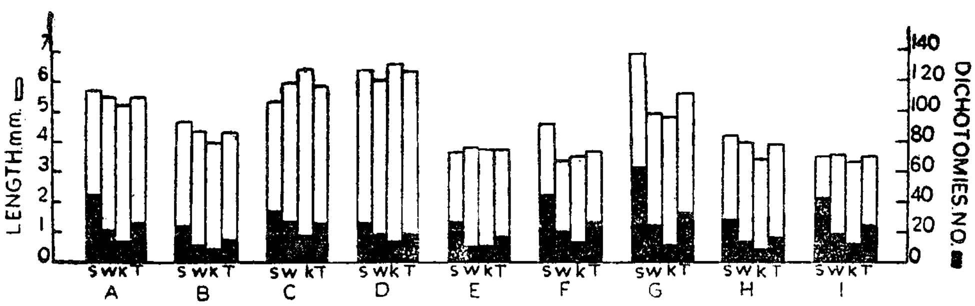


Figure 11. Histogram comparing the average length with the mean number of dichotomies of standard (s), wing (w), keel (k) and total corolla (T) in different species.

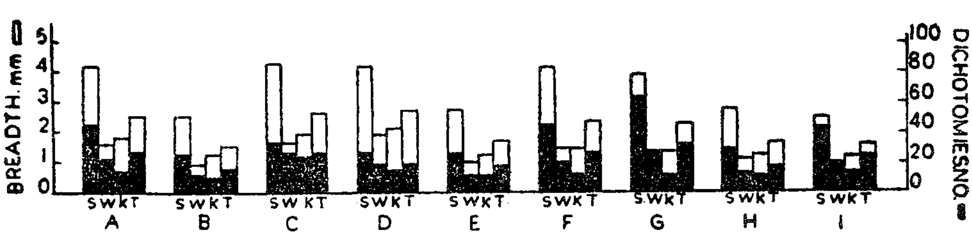


Figure 12. Histogram comparing the average breadth with the mean number of dichotomies of standard (s), wing (w), keel (k) and total corolla (T) in different species.

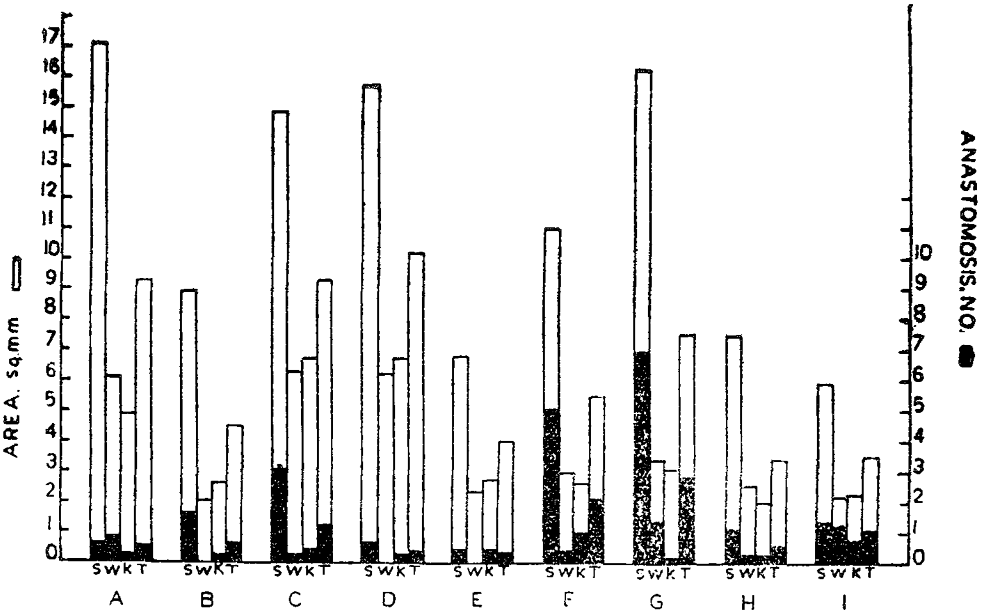


Figure 13. Histogram comparing the average area with the mean number of anastomoses of standard (s), wing (w), keel (k) and total corolla (T) in different species.

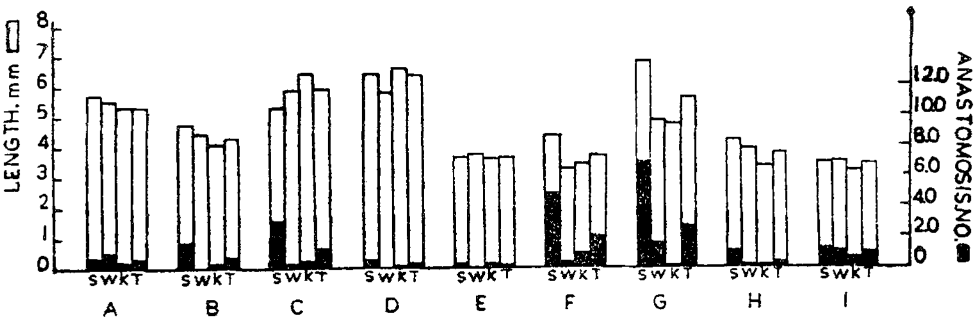


Figure 14. Histogram comparing the average length with the mean number of anastomoses of standard (s), wing (w), keel (k) and total corolla (T) in different species.

Abbreviations : A = *T. arabica* , B = *T. caerulea* ; C = *T. callicerasoites* ; D = *T. corniculata* ; E = *T. cretica* ; F = *T. gracilis* ; G = *T. polycerata* ; H = *T. stellata* ; I = *T. suavissima.*

3.2. *Anastomoses*

The open dichotomous venation becomes complicated at places by vein fusions. The percentage of petals showing vein fusions varies from 20–66·6% (table 2). A slight positive correlation has been observed between the length or area of petals and the number of anastomoses (figures 13–14). In most of the petals anastomosing is generally found at one point. Among the different types of anastomoses *C* and *D* types are of most frequent occurrence in all the species (table 3). In all the species vein anastomoses are generally concentrated in the

Table 2. Percentage of petals showing anastomoses.

Sl. No.	Name of the species	Total (%)	Points of anastomosis				
			1	2	3	4	5-10
1.	*T. arabica*	40·0	66·6	33·34	..	..	..
2.	*T. callicerassoites*	53·4	37·5	25·00	25·0	12·5	..
3.	*T. caerules*	40·0	66·6	33·34	..	..	..
4.	*T. corniculata*	20·0	66·0	33·0	..	..	..
5.	*T. cretica*	20·0	66·0	33·0	..	..	..
6.	*T. gracilis*	71·4	80·0	10·0	..	10·0	..
7.	*T. polycerata*	66·6	20·0	30·0	..	10·0	40·0
8.	*T. stellata*	33·3	80·0	..	20·0	..	..
9.	*T. suavissima*	66·6	60·0	20·0	10·0	10·0	..

Table 3. Percentage of different types of anastomoses.

Sl. No.	Name of the species	*A*	*B*	*C*	*C′*	*C″*	*D*
1.	*T. arabica*	25·00	25·00	25·00	..	..	25·00
2.	*T. callicerasoites*	..	..	66·60	..	..	33·34
3.	*T. caerulea*	..	11·11	77·78	..	..	11·11
4.	*T. corniculata*	..	25·00	50·00	..	..	25·00
5.	*T. cretica*	..	..	25·00	75·00	..	..
6.	*T. gracilis*	11·11	..	44·44	11·11	11·11	22·22
7.	*T. polycerata*	6·96	6·96	41·86	4·64	2·32	37·21
8.	*T. stellata*	..	..	57·14	..	..	42·86
9.	*T. suavissima*	11·76	35·89	35·89	5·08	..	11·76

central region except the standard petal of *T. polycerata* in which they are more in the peripheral region.

4. Discussion

The petal venation of this genus has shown some interesting features. Arnott and Tucker (1964) reported significant correlation between size (length, width, area) and number of dichotomies. In this paper a positive correlation is found with the length and area only. They have also given importance to the position of the dichotomies. In the present study maximum number of dichotomies is found in the central region except the standard petal of *T. cretica* and *T. corniculata* in which it is found in the basal region. Generally no correlation is found between the frequency of anastomoses and length of the petals. However, the petals of *T. arabica*, *T. polycerata* and *T. gracilis* have shown a positive correlation. Just like the length no correlation is found with the area excepting the petals of *T. caerulea*, *T. corniculata* and *T. polycerata*. Thus from above it is clear that frequency of anastomoses is not dependent upon the area or the length of the petals. In all the species highest frequency of anastomoses is found in the central region but the wing petals of *T. arabica* and keel petals of *T. corniculata* and *T. stellata* possess highest frequency in the basal region. Datta and Saha (1968) reported highest frequency in the peripheral region in the members of phaseolae.

Among the different types of anastomoses *C* and *D* types are of most frequent occurrence in all the species studied except *T. cretica* in which *C* and *C′* are common. Earlier Datta and Saha (1968) have also reported the frequent occurrence of these types for the members of phaseolae and Arnott and Tucker (1963) for *Ranunculus repens*. In addition to these types only *B* type is found in *T. caerulea* and *T. corniculata*, *A* and *B* in *T. arabica*, *A*, *B*, *C′* in *T. suavissima*, *A*, *C*, *C″* in *T. gracilis* and all types in *T. polycerata*. Thus in this genus distribution of anastomoses appears species specific. Among the different species more points of fuisons are found in *T. polycerata*, *T. callicerasoites*, *T. gracilis* and *T. suavissima*.

Foster and Arnott (1960), Banerji and Mukherji (1970), and Subramanyam and Nair (1973) are of opinion that open dichotomous venation is primitive while on the other hand Chertek (1962, 1963) views that anastomosed venation is primitive. The present study supports the former view and among the species of this genus *T. callicerasoites*, *T. gracilis*, *T. polycerata* and *T. suavissima* appears to be more advanced as these species have more points of fusions and more number of petals showing vein fusions.

Earlier reports indicate that species of *Trigonella* are characterized by presence of both simple as well as medicagoid type of corolla. In the present investigation simple corolla is found in all the species except *T. polycerata* in which it is of medicagoid type. The wing petal of *T. polycerata* possesses a tooth like structure arising from the inner surface of the petal and receiving supply from the main bundle of the petal. In this region vascular bundles are inversely oriented with respect to the petal bundle. The same inversely oriented supply was reported by Arber (1936) for the nectary of *Ranunculus* and for the corona by *Narcissus* (Arber 1937). Thus this tooth like structure may be regarded as petalline nectary or corona. Earlier Larkin and Graumann (1954) named this structure as horn in *Medicago sativa*, Thus it can be concluded that among the different species of this genus *T. polycerata* is the highest evolved species.

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