ORGANOGRAPHIC STUDY OF VESSEL ELEMENTS IN THE GENUS *GOSSYPIUM*

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ABSTRACT

The present study describes vessels in root, internode, node, petiole and leaf with reference to size, shape and number and inclination of perforation plates along with adjacent wall thickening. The nodal and internodal vessels differ in their size. Both leaf and petiole possess narrow, tubular, long vessels either simple, bordered, scalariform or reticulate pits, showing least specialization than the other organs. The adjacent wall thickening is simple, pitted only in the remaining organs. The number of perforation plates are one to three. Highly specialized vessels are present throughout the plant in four species and eight varieties of the genus *Gossypium* studied and specialization is unidirectional starting from the root to shoot system up to the leaves.

INTRODUCTION

Tracheary elements of the complex xylem tissue play a vital role in transporting the water and support to some extent to the plant. The vessel member or element has been considered a key unit of the xylem to understand its evolution and elucidate, if possible, the phylogenic relationship of the various taxonomic groups of the plants. Development of vessels in angiosperms and their significance in morphological research has been studied by BAILEY (1944). CHEADLE (1943a, 1943b, 1944, 1953) and CHEADLE AND KOSAKAI (1971, 1972, 1973, 1974, 1975) in a series of papers described the occurrence, trends of specialization and taxonomic significance of vessels in various organs of different monocot families. BAILEY (1957) pointed out the ranges of variability in the various xylem elements especially the vessel members in individual genera and species. Very few workers studied the internodal vessels in dicots (LEMESLE, 1953 ; SHAH, 1954, 1966, 1967 ; ABBE & ABBE, 1971 ; INAMDAR & MURTHY, 1977 ; ALEYKUTTY & INAMDAR, 1978 ; MURTHY *et al.*, 1978). But no attempt has been made to study the vessels at organographic level in the genus *Gossypium*. It is possible that this type of investigation may throw light on the range of variability and evolution, inter-relationship of various morphological features of vessel members.

MATERIAL AND METHOD

The seeds of *Gossypium hirsutum* L. varieties *hybrid-4*, *varalakshmi*, g. cot. 100 ; *G. arboreum* L. var. n. *sanjay* ; *G. barbadense* L. var. *suvin* and *G. herbaceum* L. varieties *digvijay*, *v-797*, *sujay* for the present study were brought from cotton research station, Surat and grown in the university garden. Different organs (root, internode, node, petiole and leaf) were macerated following the method of JANE (1957). The macerated material after thorough washing was stained in Delafield haematoxylon and temporary preparations were made for observations. The vessels are grouped into size classes viz : short, medium and long for convenience. Vessels were measured from tip to tip. Descriptions of number, disposition of perforation plates and adjacent wall thickening that exceeded 50 per cent of the total percentage are referred to as "common" and 25 per cent to as "occasional"

Table 1—Showing the average size of vessel elements in the genus *Gossypium*

S. no.	Name of species	Organ	Short		Medium		Long		Average	
			L in μm	D	L in μm	D	L in μm	D	L in μm	D
1	2	3	4	5	6	7	8	9	10	11
1.	*G. hirsutum* L.	R	159	88	250	76	359	74	256	79
	var. *hybrid-4*	In.	181	83	264	88	372	69	272	80
		N	137	71	276	66	..	..	206	68
		P	202	28	252	35	604	33	353	32
		L	143	33	252	21	..	..	198	27
2.	*C. hirsutum* L.	R	114	81	250	92	..	..	182	87
	var. *varalakshmi*	In.	145	86	278	74	379	71	267	77
		N	138	57	274	74	424	41	275	57
		P	171	31	279	29	..	..	225	30
		L	140	32	260	33	..	..	200	33
3.	*G. hirsutum* L.	R	131	105	259	69	..	..	195	87
	var. *g. cot. 100*	In.	198	109	293	98	398	78	296	75
		N	143	78	252	88	..	..	198	83
		P	..	..	326	50	440	41	383	46
		L	128	38	265	28	..	..	197	33
4.	*G. arboreum* L.	R	160	79	..	..	..	..	160	79
	var. *sanjay*	In.	170	85	260	75	340	40	256	66
		N	162	69	259	50	..	..	211	60
		P	191	26	274	26	..	..	233	26
		L	174	24	229	22	..	..	202	23
5.	*G. barbadense* L.	R	171	88	283	86	382	62	279	78
	var. *suvin*	In.	148	67	274	86	..	..	211	77
		N	176	86	303	83	..	..	240	85
		P	179	35	255	41	391	50	275	42
		L	171	33	288	35	352	28	270	32
6.	*G. herbaceum* L.	R	148	98	250	83	..	..	199	91
	var. *digvijay*	In.	172	93	271	71	..	..	222	82
		N	157	79	259	69	..	..	208	74
		P	..	..	262	36	344	38	303	37
		L	156	23	291	28	..	..	224	62

1	2	3	4	5	6	7	8	9	10	11
7.	*G. herbaceum* L.	R	143	83	241	66	..	..	192	75
	var. *v-797*	In.	162	85	278	72	..	..	220	79
		N	216	45	281	27	388	38	295	37
		P	191	48	305	36	410	41	302	42
8.	*G. herbaceum* L.	R	153	72	228	59	..	..	101	66
	var. *sujay*	In.	169	79	229	71	..	..	199	75
		N	148	62	271	47	..	..	210	55
		P	..	..	255	35	407	36	331	36
		L	176	26	281	24	..	..	229	52

R—Root ; In.—Internode ; N—Node ; P—Petiole ; L—Leaf. L—Length ; D—Diameter.

and less than 25% to as "rare". Camera lucida drawings were made from temporary preparations. Microphotographs were taken with Carl Zeiss photomicroscope-I. The term vessel is used interchangeably with vessel member unless meaning is thereby obscured.

OBSERVATION

The vessels in different organs viz : root, internode, node, petiole and leaf were studied with reference to dimensional characters ; shape, number and disposition of perforation plates and adjacent wall thickening. The vessel elements features in different organs are as under :

Root

The maximum vessel element average length and width are observed in *suvin* (279 μm) and *digvijay* (81 μm), respectively. *G. hirtsutum* varieties have more length and width than the Asiatic varieties (except *digvijay*). The minimum vessel element length is 160 μm in *sanjay*. Vessel elements are mostly cylindircal (Pl. 1 : M) or drum-like (Pl. 1 : H, J) and rarely conical (Pl. 1 : O, P) or spindle-like (Pl. 1 : L). The perforation plates are simple, usually two, rarely three or one (Pl. 1 : S). The perforation plates are mostly circular/lenticular and rarely triangular in shape. The inclination of perforation plates may be median and transverse or nearly so or oblique/lateral rarely. The adjacent wall thickening is simple pitted. Simple pits are circular or elongated and slightly variable in size.

Internode

G. hirsutum varieties are having maximum length ranging from 267 μm to 296 μm than the Asiatic varieties and *G. barbadense* var. *suvin*. The maximum diameter is 82 μm in *digvijay*. The internodal vesse lsare mostly cylindrical (Pl. 1 : K, N) or drum-like. The perforation plates are simple and usually two. The perforation plates are mostly circular and rarely tetragonal. The inclination of perforation plate may be median commonly, transverse to lateral occasionally. The adjacent wall thickening is simple pitted either circular or elongated (Pl. 1 : G).

Node

In all investigated varieties, except *varalakshmi* and v-797, the nodal vessles would not fall under the category of long. The average maximum and minimum vessel element lengths are 295 μm in v 797 and 198 μm in g. cot. 100. The average maximum and minimum vessel element diameter is 85 μm in *suvin* and 37 μm in v-797. The vessel elements are commonly cylindrical, occasionally spindle-like and rarely conical. The number of perforation plates commonly two, occasionally one and rarely three (Pl. 1 : Q). The perforation plates mostly circular and rarely lenticular in shape. The adjacent wall thickening is simple pitted.

Petiole

Except *sanjay*, the remaining varieties would fall under three categories long, medium and short. The maximum vessel element average length and diameter are 383 μm and 46 μm in g. cot. 100. The minimum vessel element length and diameter are 233 μm and 26 μm in sanjay. The petiolar vessel elements are commonly cylindrical (Pl. 1 : B) ; rarely conical. The perforation plates are mostly two or rarely three in *digvijay*. The perforation plate shape is either circular or lenticular. The adjacent wall thickening is either simple pitted, alternately (Pl. 1 : B) ; or oppositely (Pl. 1 : A) ; scalriform (Pl. 1 : C) ; bordered (Pl. 1 : D) or rarely reticulate.

Leaf

The maximum and minimum vessel element length is 270 μm in *suvin* and 155 μm, in v-797. The vessels are commonly tubular (Pl. 1 : E, F) and rarely conical or spindle-like. The adjacent wall thickening is simple pitted commonly and rarely reticulate (Pl. 1 : E, F). The perforation plates are commonly two, mostly lenticular in shape.

DISCUSSION

According to CHEADLE (1943a, 1943b) the perforation plates in the congested regions are not fundamentally different from those in the less congested areas.....the character of the perforation plate seems most constant under all conditions with in an organ. CHEADLE (1943a) is of the opinion that "the vessels are most specialized in roots and are progressively less specialized up to the shoot system to the leaves, where they are least specialized". It appears that vessel specialization is unidirectional (1943a, 1944, 1953) and is typical to monocotyledons.

CHEADLE (1944, 1953) and CHEADLE AND KOSAKAI (1971, 1972, 1973, 1974, 1975) discussed the occurrence, trends of specialization, phylogeny and taxonomic significance of vessels in various organs of monocot families. SHAH *et al.* (1966, 1967) made a comparative study of nodal and internodal vessels in the stems of *Dioscorea alata* L. and concluded that nodal and internodal vessels show similarities and differences in their size, shape, number, distribution and inclination of perforation plates. It is only in this laboratory efforts are being made for extensive and intensive study of vessels in different families of dicotyledons.

The inclination of perforation plates is mostly median and occasionally transverse to oblique (except *G. herbaceum* varieties) of root and stem. The nodal vessels differ from internodal vessels in their dimensional characters, the former being comparatively shorter than the latter generally. The vessels in petiole and leaf are showing least specialization by possessing narrow, tubular vessels. Both scalariform and bordered pits are present in petiole. In case of leaf rarely reticulate pitting is observed. But for this, mostly alter-

nately arranged simple pits are present in all organs. So the root vessels are highly specialized by possessing shorter and broader vessels with transversely and medianly oriented perforation plates.

Simple perforation plates occur on a wide variety of vessels in different organs and vary from one to three irrespective of vessel size. Therefore, it is difficult to correlate the size of vessel and the number of perforation plates. Simple perforation plates are derived from multiple type by the gradual disorganisation of the separation wall, which in due course develop into a single perforation plate which is considered to be highly specialized. Similarly, the side wall pitting is also not confined to particular type of vessels because long, narrow vessels in leaf and petiole and broad vessels in the remaining organs show simple pits. So highly specialized vessels are present throughout the plant in four species and eight varieties of *Gossypium* studied.

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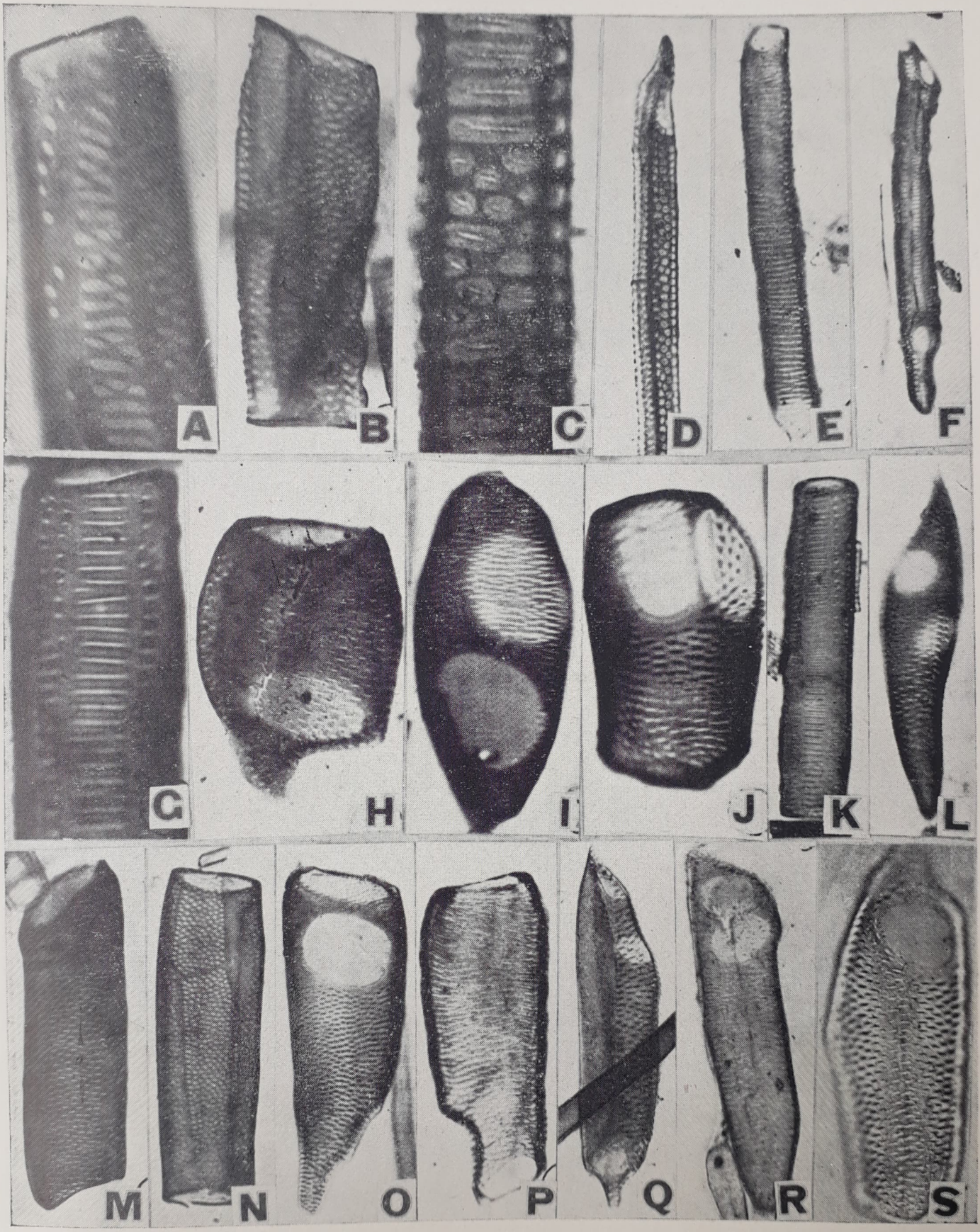
EXPLANATION TO PLATE-1

A. V-797 Petiole, B. V-797 Petiole, C. D. G. cot. 100 Petiole. E. G. cot. 100 Leaf, F. Sanjay Leaf, G. V-797 Internode, H. V-797 Root, I, J. Varalakshmi Root, K. V-797 Internode, L. Suvin Root, M. Varalakshmi Root, N. Suvin Internode, O. P. Suvin Root, Q. Varalakshmi Node, R. Sujay Root, S. Digvijay Root.

(A= ×373 ; B— ×640 ; C— ×806 ; D— ×100 ; E— ×327 ; F— ×238. G— ×970 ; H— ×320 ; I— ×550 ; J— ×695 ; K— ×390 ; L— ×400 ; M— ×457 ; N— ×800 ; O— ×370 ; P— ×570 ; Q— ×250 ; R— ×377 ; S— ×400).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