

For example Aubrecht and Scott derived<sup>8</sup>  $m_u = m_d = 0.298$  GeV,  $m_s = 0.497$  GeV,  $m_c = 1.54$  GeV,  $m_b = 4.73$  GeV and  $m_t = 14.7$  GeV. On the other hand Aerts and Heller<sup>9</sup> recently applied the Born-Oppenheimer approximation to the MIT bag model and obtained  $m_u = 0.571$  GeV,  $m_c = 1.872$  GeV and  $m_b = 5.237$  GeV.

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## A CONTRIBUTION TO THE FLORAL ANATOMY OF *PHRYMA LEPTOSTACHYA* L.

R. V. RAMANA, P. S. PRAKASA RAO AND L. L. NARAYANA\*

Department of Botany, Nagarjuna University, Nagarjunagar 522 510, India.

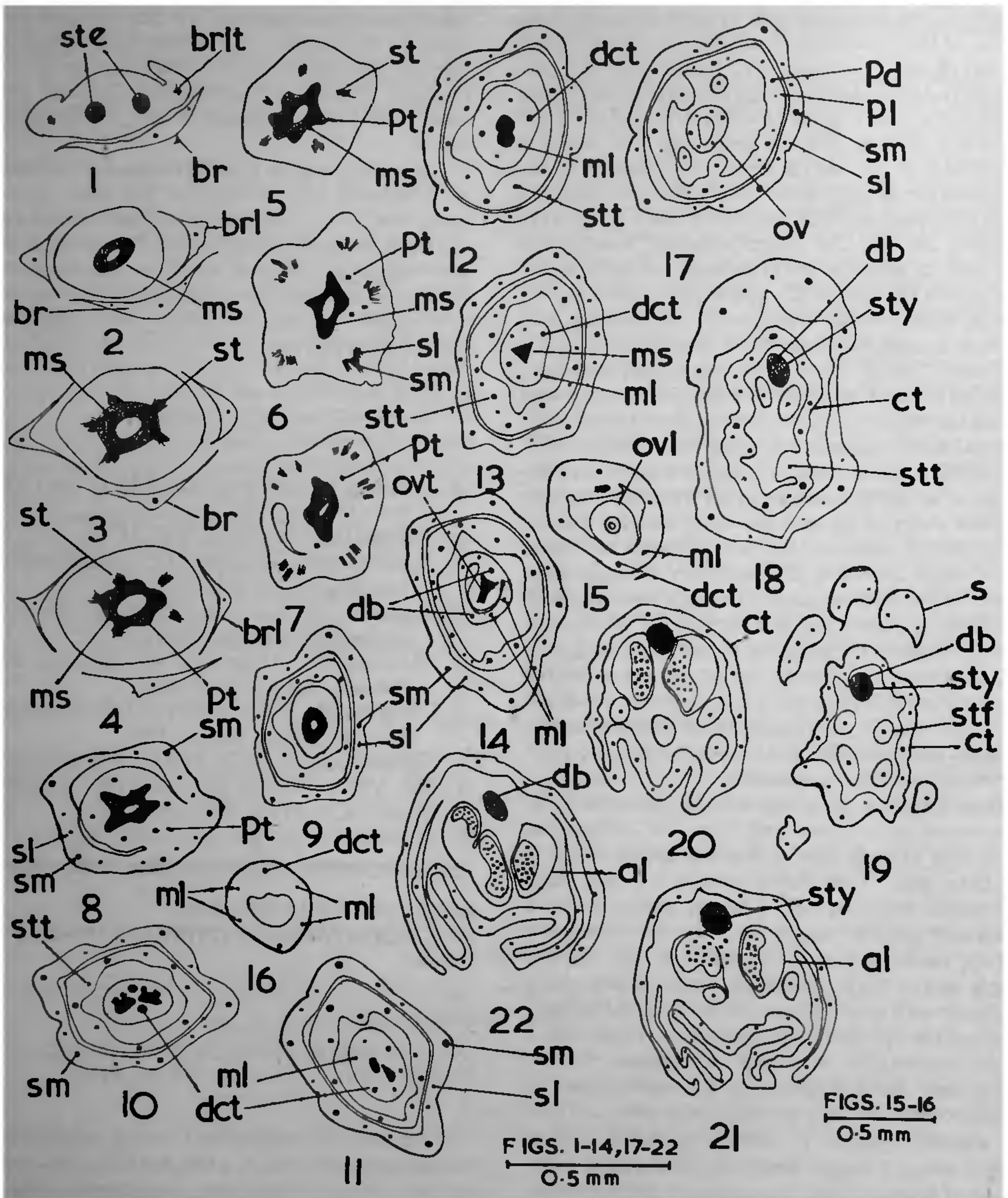
\*Department of Botany, Kakatiya University, Vidyanayapuri, Warangal 506 009, India.

THE herbaceous monotypic genus *Phryma* L., with bicentric distribution in moist, deciduous or mixed forests of eastern North America and South East Asia, seems to be of somewhat uncertain taxonomic position. It was referred to the Verbenaceae<sup>1-3</sup>. It was also assigned<sup>4,5</sup> to an independent family Phrymaceae on the basis of the presence of single ovule in the unilocular ovary. This treatment was followed and it was included in Lamiales<sup>6</sup>. The morphoanatomical features of *Phryma leptostachya* L. was studied<sup>7</sup> in a casual way and this work embodies very few observations concerning the genesis of floral parts and their vasculature. There is, however, no other published

work so far on the floral anatomy of *Phryma*. The present work, therefore, was undertaken to amplify details of the features of vasculature of the flower of *Phryma leptostachya* L. and to clarify the systematic status of the genus.

The flowers are grouped in both terminal and axillary long pedunculate spicate racemes. The flowers are bracteate, bracteolate, complete, hypogynous and tetracyclic with floral formula  $K_{(5)}, C_{(5)}, A_4, G_{(2)}$ . The sympetalous calyx is persistent and 2-lipped displaying 3 and 2 condition (figure 19) and accrescent in fruit. The upper lip of sympetalous tubular corolla comprises two members and encloses the tripartite lower lip (figures 20-22). The four epipetalous stamens are included and the anthers are 4-sporangiate; the posterior stamen being completely suppressed. The posterolateral stamens are shorter than the antero-lateral ones and the anthers stand out at different levels. The 2-carpellary syncarpous pistil is 1-ovulate (figures 15, 16). The ovule is sub-basal and is borne on the placenta, which is fused with the ovary wall along the anterior side. The filiform glabrous terminal style is included in the flower and terminates in a bifid stigma.

The two bracteoles, which are almost opposite to one another, arise above the 3-stranded bract and at slightly successive levels on the floral axis, receive a trace from each of the corresponding stele/vascular bundle of the 2-steled/bundled floral axis (figures 1 & 2). The two prominent steles/vascular bundles after giving off those to the corresponding bracteoles (figures 1 & 2), fuse to organise a closed ring of main stele, the simple siphonostele (figure 2). Five strong sepal traces emerge symmetrically from the main stele (figures 3-5) and prior to their entry into the base of the sepals, each trace branches into a median and pair of lateral traces (figure 6). Thus, the sepals are 3-traced and the sepal laterals originate conjointly with the midribs (figures 6 & 7). At a slightly higher level of the sepaline vasculature from the axial cylinder a second whorl of five traces alternating with the sepaline traces depart for the petals (figures 6-8). Four staminal traces are then produced alternating with the petaline traces from the main stele (figures 9-11). There is no external or anatomical evidence of the suppressed posterior stamen (figures 9 & 10). The nine (5 petal and 4 staminal) traces enter the corolla tube (figures 9-11). The petaline bundles remain unsegmented in the greater part of the corolla tube (figures 9-12), but at its throat each bundle gives rise to a petal dorsal and a pair of petal laterals (figures 13 & 14). At the level of divergence of the filaments no branches of the staminal traces are left behind in the corolla tube and traces depart from the ring and enter the filaments, ultimately ending in the connective (figures 17-19).



Figures 1-22 *Phryma leptostachya* L. Serial cross-sections of the flower from base upwards (al-anther lobe; br-bract; brl-bracteole; brlt-bracteole trace; ct-corolla tube; db-dorsal bundle; dcl-dorsal carpellary trace; ml-median lateral; ms-main stele; ov-ovary; ovl-ovule; ovt-ovular trace; pd-petal dorsal; pl-petal lateral; pt-petal trace; s-sepal; sl-sepal lateral; sm-sepal midrib; st-sepal trace; stf-staminal filament; stt-staminal trace; sty-style).

After giving off traces to the sepals, petals and stamens, the remaining stele assumes once again the form of the closed ring (figure 9). At this level a few layers of cells of the floral axis lying outside the main stele are deeply stained. From the closed ring of main stele two dorsal carpellary traces are the first to demarcate and emerge from the remaining stele, which is discerned as two lateral bands, two median lateral traces organise and traverse higher up into the ovary wall and ultimately fade away at the apex of the ovary (figures 10-17). The primary dorsal bundles run through the whole length of the style and fade away in the stigma (figures 18-22). Subsequent to the organisation of the median lateral traces, the two common ventral bundles fuse together to form a core of vascular tissue (figures 11-13). The ventral supply extends into the placenta which is fused with the the ovary wall along the anterior side. At about this level the core-like ventral tissue assumes triangular outline (figure 13). The ovule receives a massive trace from posterior angular part, while the traces given off from the other two angular zones of the vascular tissue traverse into the placenta and eventually fade away (figures 14-16) and these traces represent the supply to the suppressed ovules of the anterior carpel. The single surviving ovule, therefore, captures the vascular supply of the suppressed ovule of the posterior carpel also. The gynoeceal condition may, thus be interpreted as one derived from a 2-carpellary syncarpous 4-loculate condition with one ovule in each locule borne on anatomically parietal placenta. The pistil can, therefore, be described as pseudomonomerous.

Thus, from the foregoing description of the floral vasculature of *Phryma* and from the comparison made with existing data<sup>8</sup> it becomes apparent that in the basic plan of the flower and in essential floral anatomical features, like, 3-traced sepals, 1-traced petals and stamens, suppression of posterior stamen and its vasculature and the nature of the vascular supply to the pistil, this taxon seems to bear close similitude with some verbenaceous taxa, particularly those of the sub-family Verbenoideae. It has also a feature compatible with that of *Lantana*, *Lippia*, *Petrea* and *Stachytarpheta* in the abortiveness of anterior carpel, but may be reckoned as advanced over the aforesaid genera in having 1-loculate and 1-ovulate ovary. Further, despite its close alliance with certain of Verbenoideae, it preserves its distinctiveness in having such features, like, the reflexed fruit, traces arising independently from the main stele to the different whorls of the flowers, uniloculate and uniovulate condition of the ovary and the sub-basal ovule showing upwardly directed micropyle. From the analysis of the features of the monotypic genus *Phryma*, the impression gained is that the placement of this genus, which

manifests a separate evolutionary history from the other taxa of Verbenaceae, in a new tribe Phrymeae seems to be justified. The present study would then support the contention of earlier workers<sup>1-3,9,10</sup> in retaining *Phryma* in Verbenaceae, although Cronquist<sup>6</sup> preferred segregating it into an independent family.

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#### BREEDING BEHAVIOUR IN *PSEUDODRYNARIA CORONANS* (WALL.) CHING

S. P. SINGH AND S. K. ROY  
Centre of Advanced Study in Botany Banaras  
Hindu University, Varanasi 221 005, India.

THE reproductive mechanisms, which determine the distributional patterns of a fern taxon can be studied in their uniquely free-living, autotrophic gametophytes. A number of morphological features such as the sequence of gametangial ontogeny, their location on the gametophyte and the frequency of unisexual gametophytes influence the determination of intra-gametophytic selfing or inter-gametophytic crossing to take place in a population of gametophytes. The extent of the genetic load in the sporophyte of a fern is