

measured, using the reagent, under corresponding conditions as reference. Concentration of molybdenum can then be determined from the calibration curve obtained earlier using solutions of known strength.

SUMMARY

3-Phenyldaphnetin (3-phenyl-7, 8-dihydroxycoumarin) in ethanolic solution forms aqueous alcohol soluble yellow complex with molybdenum. The complex obeys Lambert-Beer's law between 1.7 ppm to 5.7 ppm of molybdenum in solution and has the composition of 1:1. Interference due to various ions has been studied. Stability constant of the complex under the experimental conditions is 4.5 ± 0.2 .

ACKNOWLEDGEMENT

The authors are grateful to Prof. T. R.

Seshadri, F.R.S., for his keen interest and helpful discussions.

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ARE TENDRILS OF VITACEAE AXILLARY?

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TENDRILS of Vitaceae are of considerable interest from morphological and ontogenetic view-points. The tendril is considered a modification of an entire shoot apex or a part of the shoot apex due to dichotomy or unequal division of the shoot apex (refer Shah¹ for detailed references). If the tendril is homologized with a lateral branch, several types of morphogenetic development are considered. It is stated that the tendril has developed from (a) an extra-axillary bud opposite to the leaf, (b) an axillary bud with its axillant leaf aborted, (c) an axillary bud originating at the node below and carried upward by intercalary growth of the internode, (d) a branch of the aborted prophyll of the bud axillant to the leaf opposite the tendril which rotates around the vine-shoot through 180° to have an opposite position and (e) a tendril is a composite structure consisting of a "hypoclade" bearing a displaced leaf of the main stem. The bud axillant to this leaf is differentiated as the other part of the tendril (Shah,¹ Chadeaud,² Bugnon,³ Millington⁴).

Shah¹ discussed these various interpretations and on the basis of ontogenetic study, he concluded that the tendril and the inflorescence of *Cissus* (and perhaps of other genera of the Vitaceae) are interrelated morphological organs whose development from the extra-axillary bud meristem depends upon the vegetative and reproductive phases of the shoot. Recently Millington⁴ interpreted the tendril of *Parthenocissus*

inserta as a modification of an axillary bud of type C as mentioned above. The present communication deals with this interpretation along with our observations based on the ontogenetic studies of adult shoot apices of *Parthenocissus quinquefolia*, Planch (obtained from the Arnold Arboretum), *Cayratia carnosa*, Gagnep., *Cissus rotundifolia*, Vahl., and *Vitis japonica*, Thumb. About 26 species of the Vitaceae obtained from U.S.A., Canada and India are under investigation.

The general arrangement of tendrils and leaves in the investigated species, including *P. inserta* is illustrated in A. According to Millington,⁴ T₁, T₄ are lower and T₂, T₅ are upper tendrils. The tendril T₁, T₂, T₄ and T₅ is a modification of the bud axillant to leaf L₁, L₂, L₄ and L₅ respectively and carried upward by an intercalary growth of the internode so as to lie exactly opposite the leaf above. The ontogenetic evidences put forth by him are as follows:

(a) The tendril is initiated at the second plastochron. It is axillary in origin though its position at the time of initiation is at the flank meristem and its final displacement is extra-axillary.

(b) The bud meristem of a tendril-less leaf, L₀ and the tendril meristem supposed to be axillant to this leaf (T₁ and L₁, T₄ and L₄ in A) are initiated simultaneously forming a "tendril-bud complex" (of T and AX in C) from which

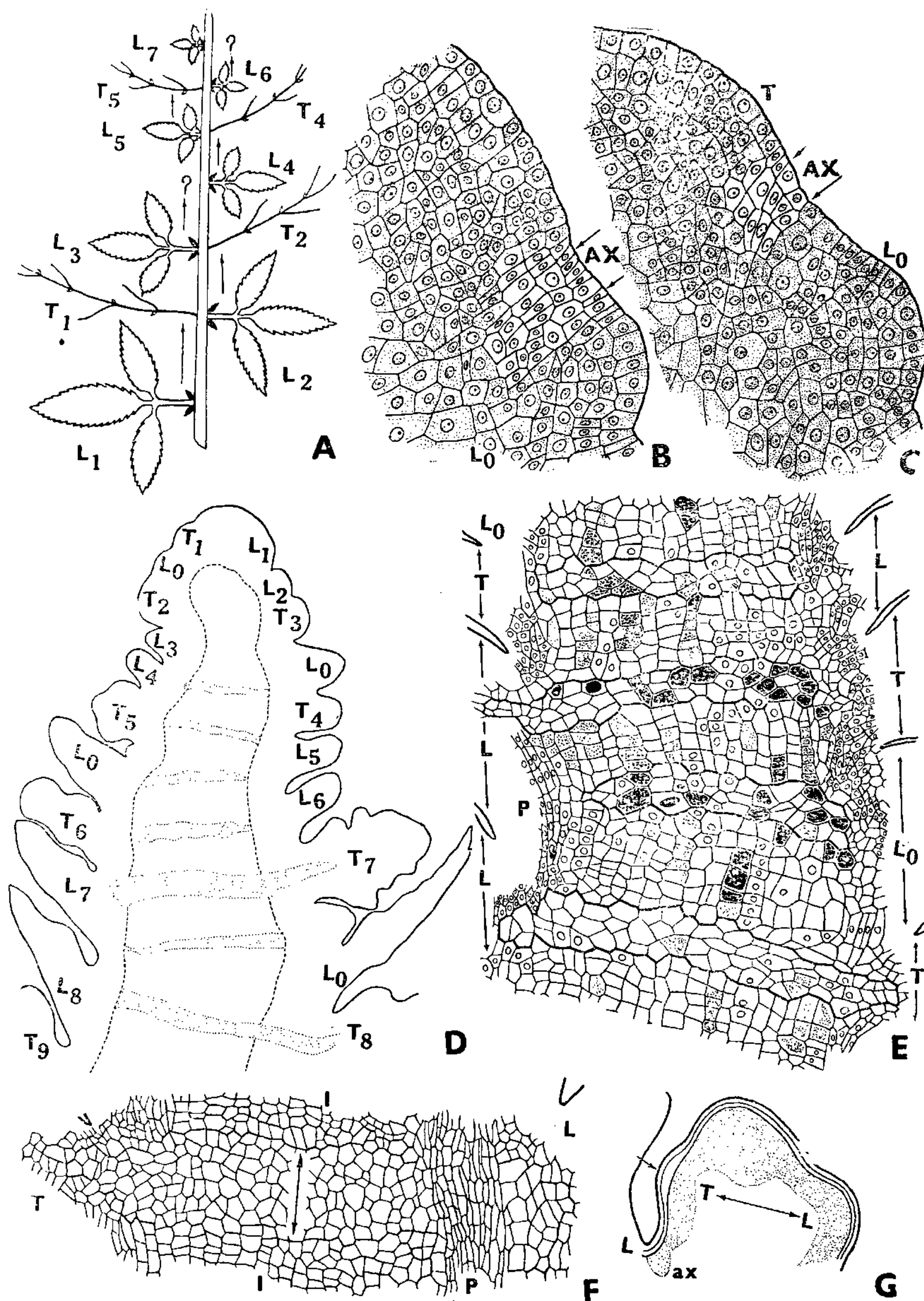


FIG. 1. A. A schematic diagram of the shoot showing the arrangement of leaves and tendrils. The arrow points to the tendril supposed to be axillant to the leaf below and question mark shows absence of any tendril for that leaf at the next higher node. B and C. L.s. shoot apex, $\times 417$. D and E. L.s. shoot tip, *Cayratia carnosha*, showing stippled nodal plate and its relation with the tendril and leaf of the

same node, $\times 67$. E. Enlarged diagram showing nodal and internodal tissues, $\times 133$. F. *Parthenocissus quinquefolia*, nodal plate at the level of tendril insertion, $\times 133$. G. L.s. shoot apex, *Cissus rotundifolia*, $\times 133$. (AX, axillary bud; I, internode; L, Leaf; L_0 , Leaf at tendril-less node; P, procambium; T, tendril).

the bud and the tendril are later differentiated. The tendril is carried upward to an extra-axillary position at the node above by intercalary growth of the internode. The tendril-bud complex has a common provascular trace.

(c) The distinct group of cells at the node forms a plate or diaphragm which lies below the level of insertion of the tendril.

In a constant tendril pattern as illustrated in A, according to Millington,⁴ each tendril belongs to the leaf situated at the node below. It also means that every leaf at its second plastochron position should subtend the tendril meristem. But as shown in A, leaves L_3 and L_6 have no tendrils above their nodes. Similarly leaf L_2 (not labelled) in Fig. 5 and L_3 (not labelled) in Figs. 8 and 9 do not subtend any axillary tendril primordium in *Parthenocissus inserta* (Millington⁴). The morphogenetic situation at the shoot apex in which some leaves will be with or without their axillant tendril primordium has remained inexplicable.

The nodal and internodal tissues are not distinctly differentiated in the pith region near the shoot apex. The positional relationship of the nodal plate vis-a-vis the leaf and the leaf-opposed tendril at lower nodes is shown in D, E and F. It indicates that the tendril and the leaf opposite to it belong to the same node. The pith of the tendril and the axis is in continuation at this level and the extension of the nodal plate tissue is a connecting link (nodal plate in T_7 and T_8 in D). All possible evidences show that the positional relationship of the tendril and the leaf concluded by Millington⁴ on the basis of the nodal plate requires reconsideration.

In *Cayratia carnosa*, the initiation of the tendril is not related to the leaf below (Shah¹). In the early stages, a constriction separates the tendril primordium from the axillary bud meristem and its subtending leaf below. The nature of development of the reproductive and vegetative buds from a common bud meristem of L_0 leaf in *Cayratia carnosa* has close bearing on the initiation and morphogenetic relationship of the tendril (Shah⁵). Unfortunately Millington⁴ has not studied the detailed ontogeny of the axillary bud in *P. inserta*. In *C. carnosa*, the initiation of the bud meristem occurs at the first node before the tendril primordium supposed to be associated with the axillant leaf below as in *P. inserta* is initiated.

In *P. quinquefolia*, the bud meristem (AX in C) axillant to leaf L_0 is differentiated and lightly stained. Periclinal divisions in the second layer indicate initiation of the tendril, T. The so-called tendril-bud complex, axillant to leaf L_0 is absent. In *Vitis japonica* tendril initiation is hardly observed at this stage in B. In *Cissus rotundifolia* a histogenic situation parallel to *P. inserta* is present but bud meristem (aX in G) is lighter stained and distinctly differentiated from the adjacent tendril buttress, T. Moreover periclinal divisions initiating the vertical growth of the tendril (arrow at T in G) occur away from the bud meristem. Photomicrograph of Fig. 9 probably represents a similar histogenic pattern in *P. inserta*, though interpreted differently by Millington.⁴

The general ontogenetic stages of development of the tendril in *P. inserta* appear to be similar to those of the investigated species. It is necessary to investigate the ontogeny of axillary bud meristem if the origin of the tendril is to be interpreted axillary. If the bud and tendril meristem is initially of one complex, either of its meristem should differentiate as an accessory bud. According to Millington,⁴ every tendril-less leaf will subtend a tendril-bud complex. But as referred above this leads to an inexplicable ontogenetic situation at the shoot apex for certain leaves subtending only axillary bud.

There is initially a single provascular trace of the tendril which in its further development differentiates into three trace strands (Shah⁶). No common vascular trace for the tendril-bud complex as reported by Millington,⁴ but not supported by any evidence, is observed.

On the basis of ontogeny, therefore, the most acceptable interpretation of the Vitaceae tendril is that morphologically it represents an extra-axillary lateral branch as in many Cruciferae, Compositae, Graminae and other families. It is admitted that thorough ontogenetic studies involving work on seedling apex and onward to the mature apex on Vitaceae are necessary for a complete understanding of this problem.

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