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STUDIES ON SOME ASPECTS OF MORPHOLOGY AND ANATOMY OF LITTLE LEAF IN *PEDALIUM MUREX* L.[1]

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ABSTRACT

The little leaf disease suspected to be caused by mycoplasma-like organisms affects many species of flowering plants around Madurai. Among these, *Pedalium murex* exhibits extreme phyllodization of flowers associated with little leaf disease. The gynoecium of phyllodized flowers is often converted into a little shoot. This change-over comes about as a result of conversion of the floral apex into a vegetative one. A comparative study of the different types of apices in these little shoots was made. The vegetative and floral apices arising out of these shoots in the phyllodized flowers exhibit a range of organization from a typical vegetative apex to a floral apex through intermediate forms. The significance of this feature in relation to the peculiar morphogenetic phenomenon in the diseased plant is discussed.

INTRODUCTION

The incidence of little leaf-associated phyllody in many flowering plants around Madurai City was reported earlier (Padmanabhan *et al.*, 1977, 1978). In this work, the extreme reduction in vegetative parts, especially the leaves, was reported. However, at present, no information is available on the structure of the apical meristems of the little shoots and much less about the floral meristems and phyllody. The present paper is based on the results of the study of apical meristems in the little shoots in *Pedalium murex* showing phyllody of flowers.

MATERIAL AND METHODS

The diseased specimens (showing phyllody) as well as healthy materials (showing normal flowers) were collected from different localities around Madurai City, fixed in FAA, dehydrated in tertiary butyl alcohol series (Johansen, 1940) and embedded in paraffin wax. Sections were cut with a rotary microtome at 10-12 μm thickness and stained with hematoxylin and erythrosin or tannic acid-iron chloride (Foster, 1934) combinations.

OBSERVATIONS

Morphology of phyllodized flowers : The little shoots form bunchy growths exhibiting no apical dominance and bearing numerous dark-green phyllodized flowers (Figs. 1, 2 and 17). The sepals become leafy (Fig. 2) and the corolla becomes thick and dark-green (Figs. 2, 19). The filaments and the anthers of the stamens were altered to varying degrees into flattened, green and leafy structures (Figs.

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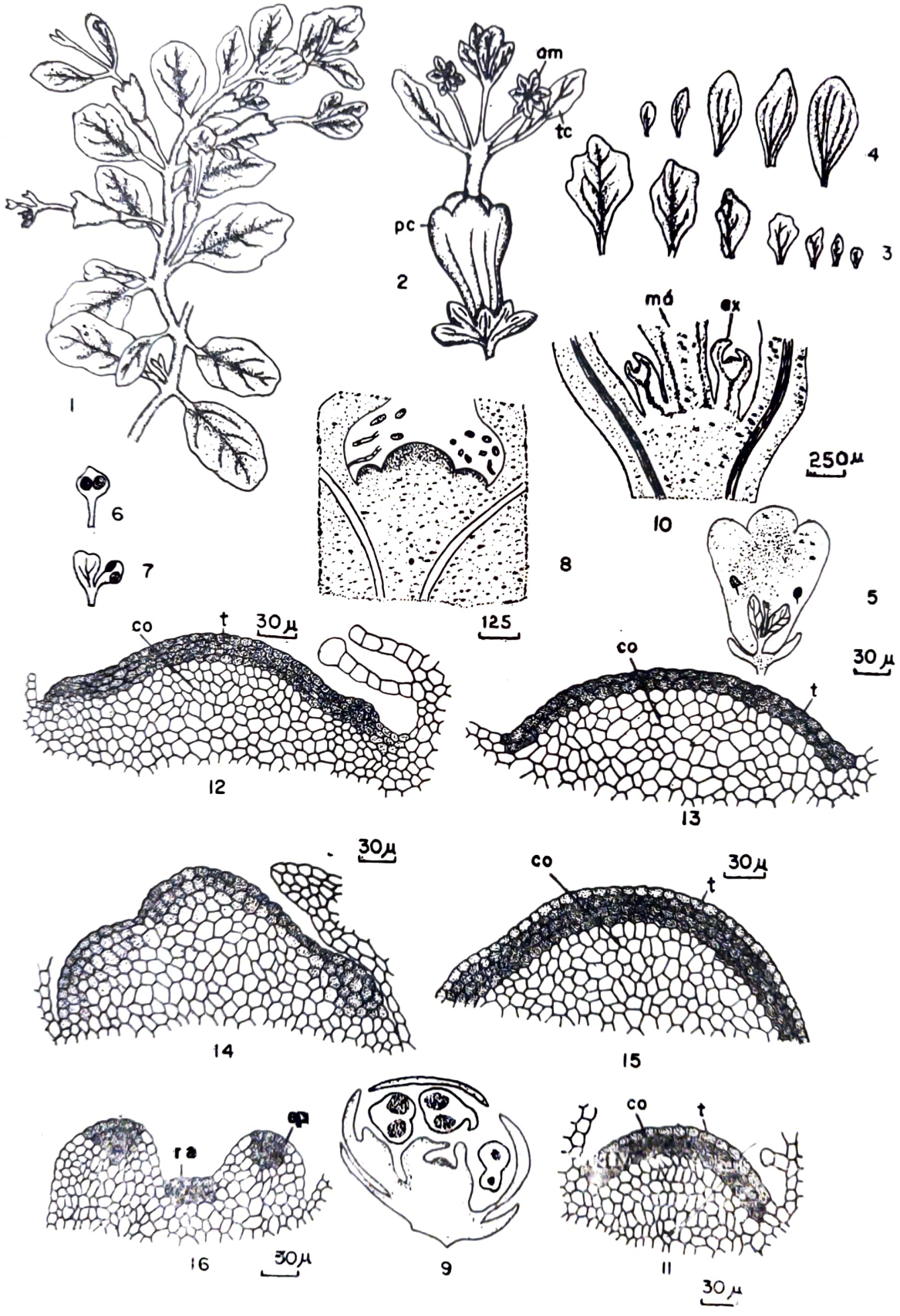
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6 and 7). The gynoecium of the normal flower is composed of a bicarpellary syncarpous ovary, a slender and long style and a bifid stigma (Fig. 18). The gynoecium in the phyllodized flower is transformed into a small leafy shoot and the carpels develop into a pair of leaves. (Figs. 5, 20 and 21). These leaves subtend a small axillary mosaic of little leaves (Fig. 2). The leaves of the mosaic show a gradation in size followed by reduction in the number of veins in each. This is similar to the condition in the little leaves of vegetative organs (Figs. 3 and 4).

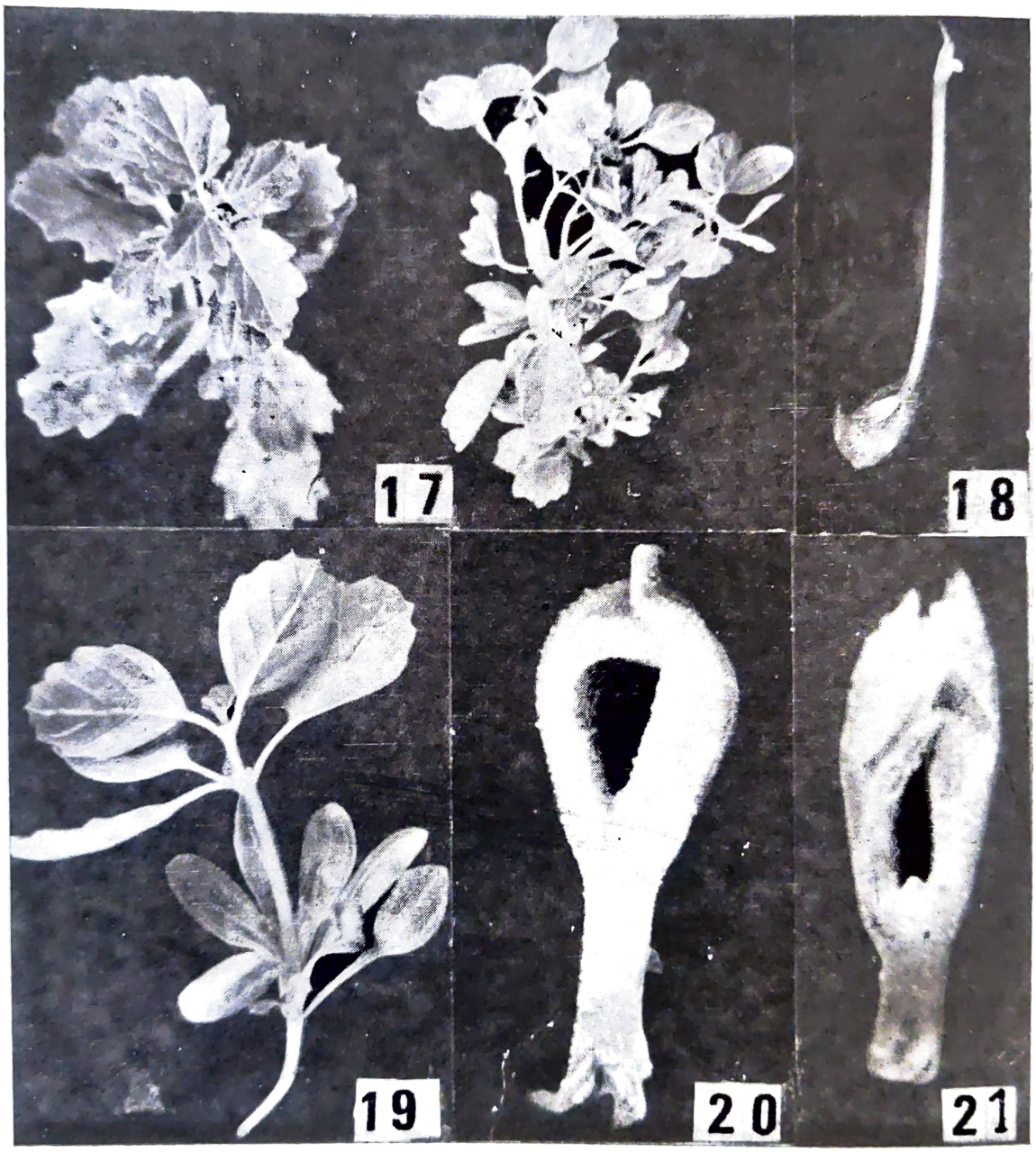
Vegetative and floral meristems of the healthy plants : The vegetative apex of the healthy shoots measures 240 μm broad and 60 μm high and the tunica is two-layered while the corpus shows a central vacuolated zone and a peripheral dark-stained flank zone besides the rib meristem. The leaf primordia arise in sub-opposite position and subtend floral primordia even before they become fully mature. Only a limited number of axillary apices develop branches. The axillary floral apices are 65 μm high and 165 μm broad and show a mantle of three to four dark-stained layers and a broad core of large vacuolated cells.

The meristems of the little shoot : The dimensions (190 μm broad and 55 μm high) of the vegetative apex of the little shoots are smaller than those of their counterparts in the healthy shoots (240 μm wide and 59 μm high) (Figs. 12 and 13). The floral apex of the little shoot shows multilayered (3-4-layered) tunica. The corpus consists of vacuolated polygonal cells.

Origin of shoots from phyllodized flowers : During phyllodization, the carpel primordia turn into leaves (Figs. 20 and 21) and the residual apex of the flower forms a short dome-shaped vegetative meristem (80 μm broad) (Figs. 9 and 16). The pair of leaves which represents phyllodized carpels is borne on a long stalk (produced as a result of elongation of the basal part of the carpels) (Fig. 5) which projects out of the leathery and green phyllodized corolla (Figs. 2 and

Figs. 1—16. *Pedalium murex*. Diagrams illustrating the morphological and anatomical features of phyllody and little leaf. Fig. 1. A shoot showing phyllodized flowers ; Fig 2. A view of a phyllodized flower showing the shoot arising in the centre as a result of transformation of carpel into leaves and proliferation of the residual meristem. The leaves subtend axillary shoots with little leaves in a mosaic ; Fig. 3. Successive little leaves from a little shoot of vegetative origin showing the progressive reduction in size and vein number ; Fig. 4. Successive leaves of little shoot of floral origin (forming mosaic) shown in Fig. 2 ; Fig. 5. Longitudinal section of phyllodized flower showing the young shoot arising out of the transformed carpels and the floral axis ; Figs. 6, 7. Views of two reduced and phyllodized ; Fig. 8. Longitudinal section through a vegetative apex. Note the precocious development of the axillary meristem of a pair of leaves. Fig. 9. Longitudinal section through phyllodized flower showing the activation of the vegetative apex in the region of the placenta ; Fig. 10. Longitudinal section through the first node of the little shoot arising out of the phyllodised flowers. Fig. 11. Enlarged view of the apices of axillary shoots shown in Fig. 10. Fig. 12. Longitudinal section through the vegetative apex of little shoot. Note the four layers of tunica. The axillary buds are precocious in development. Fig. 13. Longitudinal section through the floral apex of healthy plant. Note the two layers of tunica and a massive carpus. Fig. 14. Longitudinal section through a phyllodized flower showing the activation of the central meristematic apex. The developing apices on either side represent the axillary shoot meristems of the carpel-transformed leaves. Fig. 15. An intremediate tppe of apex from the little shoots. Fig. 16. Longitudinal section through young flower buds becoming phyllodized. The carpel primordia activated to grow as leaves. Note the reorganization of the residual apex into vegetative meristem.

(ax—axillary bud ; am—axillary mosaic ; co—corpus ; cp—carpel+primordium ; ma—main axis ; po—phyllodized corolla ; ra—residual apex ; vt—tunica; tc—transformed carpel).



Figs. 17—21. Photographs showing the characteristics of the phyllodization of flowers and associated little leaf condition in *Pedalium murex*. Fig. 17. View of a normal healthy shoot (left) and the little shoot showing phyllodixed flowers (right) (× 1/2) ; Fig. 18. gynoecium of the healthy flower (× 2) ; Fig. 19. View of a phyllodized flower, note the conversion of the petals into green leaflike organs (separated from the united corolla tube), the proliferating central axis, the carpel-converted leaves ane the shoot bud beyond (× 1) ; Fig. 20. A pair of phyllodized carpels from a phyllodixing flower ; note the axis below, which elongates to form the stem of the shoot in Fig. 19 ; Fig. 21. Same as in Fig. 20, but the carpels have turned into leaf primordia ; note the apical bud of the shoot and the little axis below (× 4)

19). Shoot buds appear in the axils of the carpellary leaves (Figs. 10, 11 and 14). Activity of these axillary buds subtended by the carpel-transformed leaves leads to prolific branching resulting in a small bunch of little shoots (Fig. 2). On these branches, the second order of phyllodized flowers appears and repeats the sequence of activities.

The effect of precoecious axillary develop-

ment : The little leaves undergo precoecious maturity even before they expand fully. The main axis often appears bifurcated or trifurcated as a result of the process of proliferation. Sometimes, when phyllodization occurs, the main apex and the precocious axillary apices present a three-lobed appearance (Fig. 8).

The intermediate type of meristem (*Fig.* 15) : The structure of the meristems that produce phyllodized flowers is essentially intermediate between that of the vegetative and floral apices of the healthy plants. The vegetative and floral apices of the little shoots differed very little from each other insofar as dimensions and the structure of the tunica were concerned. The intermediate type of organization results probably from the mixing up or the influences of the shooting and flowering responses. Thus, the floral organs lose their characteristic colouration and turn green, carpels become phyllodized and the residual meristem turns vegetative. The abnormalities of the little shoot and its flowers may be ascribed to this phenomenon.

DISCUSSION

The little leaf disease and phyllody in *Pedalium murex* was recently recorded by Padmanabhan *et al.* (1978). In this species, even though the general appearance of the symptoms broadly agrees with the general mode of disease expression recorded in other plants infected with mycoplasma-like bodies (Anjaneyulu and Ramakrishnan, 1969 ; Maramorosch, 1968 and Zelcer, 1971), phyllody is invariably associated with the appearance of little leaf and vice versa. Further, little shoots appear from phyllodized flowers and themselves bear phyllodized flowers. A comparison of the shoot apical meristems of the little shoots and healthy branches reveals some interesting facts. The shoot apical meristem of the little shoot is of smaller dimensions. The tunica is 3-4-layered and the rib meristem is weakly developed, in the little shoots the axillary apices are precocious in development and appear as small domes on either side of the main apex. There was no increase in the dimensions of the apex even after the second plastochron. The diminution of apical dimensions is probably characteristic of the little shoots in other species also. Compared to the features of normal floral apices there is a slight reduction in the size of the floral apices borne on the little shoots. The partial expression of floral organogenesis and later developments towards vegetative shoots are characteristics of phyllodization. This is probably correlated with the intermediate nature of the apical meristems of the little shoots.

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