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A STUDY ON *GRANGEA MADERASPATANA* (LINN.) POIR. : EXTERNAL MORPHOLOGY AND ANTHER DEVELOPMENT

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Grangea maderaspatana; a wild, sub-erect and woody herb, shows rossette habit. It bears branched tap-root and copiously hairy aerial parts. The disciform and yellow coloured capitulum has both outer pistillate and inner bisexual florets. The inner florets possess five, rarely four stamens. Achenial cypselas of two sizes are recorded. At times, budded capitula are reported in a mature and healthy plant. This feature is hitherto unknown to the family Asteraceae. Organogenic sequence of the floral whorls is similar in both the florets except that stamens are lacking in the outer florets. The anthers are bisporangiate. Male archesporium, having a single vertical row of hypodermal cells, appears a single celled structure in the cross-section of a young anther. The anther wall formation conforms to the Dicotyledonous type. The cells of the periplasmodial type of tapetum are uni-, or bi- nucleate and non-vacuolate. Mature endothecium reveals fibrous thickenings. The primary sporocytes divide obliquely only once. Simultaneous cytokinesis engenders tetrahedral, rarely decussate tetrads. Occasional occurrence of elongate generative cells constitutes a new report for the family Asteraceae. At anthesis, a mature pollen grain is spheroidal, spiny and three-celled.

Keywords : Asteraceae; *Grangea maderaspatana*; Microsporogenesis; Microgametogenesis; Morphology.

Introduction

The present investigation gives an account on the external features, microsporogenesis and male gametophyte of *Grangea maderaspatana*. The contribution is an attempt to add to our existing knowledge of family Asteraceae.

Material and Methods

The study material of *G. maderaspatana* was collected from moist and sandy places of Wazirabad (Delhi). Dissections and crushes were made from fresh as well as preserved material. Plant material including the small pieces of capitula of different sizes was fixed in formalin-acetic acid-alcohol for 15-18 hours and Acetic acid-alcohol for 12-14 hours, and subsequently stored in 70% ethyl alcohol. Dehydration, infiltration and embedding were done in the conventional way. Serial sections (7-11 microns) were stained in Heidenhain's Iron Hematoxylin - fast green combination. Voucher specimens have been deposited in the herbarium of H. P. University, Shimla-5, and the herbarium of H. R. College, University of Delhi, Delhi-7.

Observations

Grangea maderaspatana (Linn.) Poir. is a sub-erect, profusely hairy and woody herb, and possesses branched tap-root. The solid and cylindrical stems measure 12-30 cm. in length and spread from the centre into all directions. This gives the plant a rossette appearance (Fig. 1). The leaves are thick, sessile, coarsely serrate-dentate, hairy on both the surfaces, alternately arranged and sinuately pinnatifid with 2-4 pairs of opposite lobes. The smaller lobes are towards the base and the largest is terminal (Fig. 2).

Heads are disciform, heterogamous, yellow-coloured, shortly peduncled, terminal or leaf-opposed or in groups of 2-5, 0.6-0.9 cm. in diameter and encircled by 2 or 3 serriate hairy bracts (Fig. 3). Rarely, a mature head of a healthy plant bears a small capitulm like structure. Such budded capitulum (Fig. 4) undergoes a little growth and remains at a very young stage. Receptacle is solitary, convex and naked. Each head possesses both outer and inner florets.

The outer florets (Fig. 5) are regular, pistillate and arranged in one-many series. They possess a fringe (a ring) of persistent pappus on the rim of the floral axis and tubular corolla which is hairy, and shorter than the style. The inner florets (Figs. 6,7) are regular and bisexual. The nature of pappus

and corolla is similar to the outer florets. The androecium possesses 4 (Fig. 6) or 5 (Fig. 7) epipetalous stamens with long filaments and syngenesious anthers.

The ovary in both the florets is inferior, bicarpellary, syncarpous and unilocular with a single basal ovule. Style is long and exserted with a bifid and hairy stigma (Figs. 5-7). Fruit is an achenial cypsela with cupular pappus. Fruits developed in the inner florets (Fig. 8) are slightly larger than ones formed in the outer florets (Fig. 9).

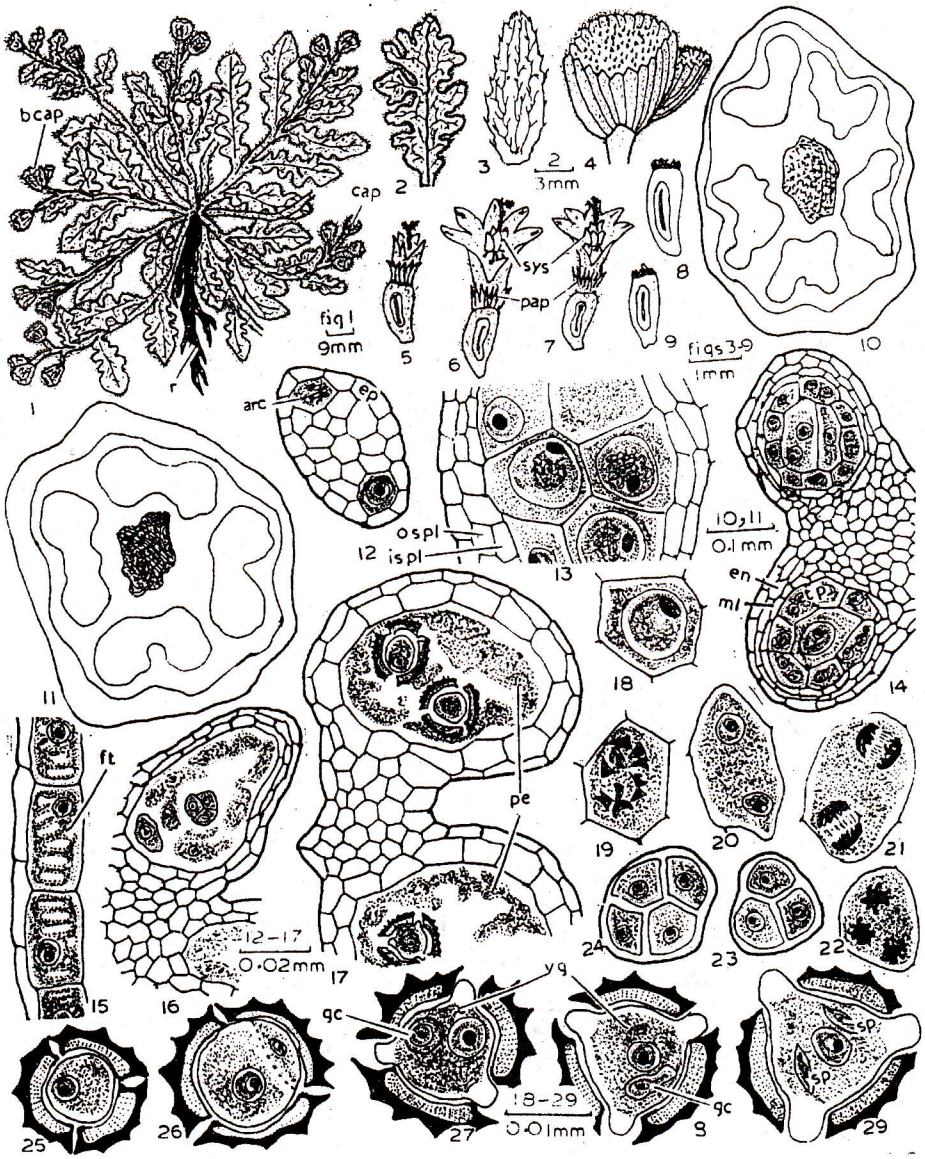
The developmental sequence of the floral whorls in the inner floret is petals, stamens, pappus (sepals) and gynoecium. The same sequence of the development is maintained in the peripheral pistillate florets, except that stamens are not grown. The stamens in the inner florets originate independently as small primordia which remain free from one and another during early stages of development (Figs. 10, 11). In the latter stages, however, the adjacent anthers cohere by their epidermal cuticle to form the anther tube.

An undifferentiated anther is a small two - lobed structure. It is made up of a mass of homogenous cells surrounded by a well-developed epidermis (ep). A vertical row of hypodermal archesporial cells differentiates in each lobe of an anther. However, a cross-section of anther (Fig. 12) reveals a single archesporial cell (arc). Each archesporial cell divides periclinally to form (ppc), the primary parietal cell on the outside and (psc), the primary sporogenous cell on the inside. The primary parietal cells further divide periclinally and later anticlinally to form (ospl), the outer and (ispl), the inner secondary parietal layers (Fig. 13). The ispl matures into (tp), the tapetum, whereas the ospl divides further to give rise to two layers of which the inner forms (ml), the middle layer and the outer develops into (en). the endothecium. The microspore mother cells, are thus, surrounded by a tapetum, single middle layer, endothecium and epidermis (Fig. 14). The anther wall development, therefore, corresponds to the Dicotyledonous type[1] (See also S. R. I).

The epidermal cells undergo only anticlinal divisions, keep pace with the enlarging anther and later are stretched. The endothecial cells elongate radially and about the time of first pollen grain mitosis, develop characteristic wall thickenings (Fig. 15). The middle layer is ephemeral and its vestiges persist until the formation of microspore tetrads (Fig. 16). The epidermis persists as a well-defined layer even in the dehisced anther.

Figs. 1-29. A study on *Grangea maderaspatana*- External morphology and anther development.

1. A complete plant; 2. Single leaf; 3. Involucral bract; 4. A capitulam showing the emergence of a bud; 5. Outer floret; 6,7. Inner florets; 8,9. Achenes formed in inner and other florets respectively; 10,11. Transections of androecia showing five and four bisporangiate anthers (diagrammatic) respectively; 12. Transections of young anther showing hypodermal archesporium; 13,14. Longisection and transection of anthers showing the formation of wall layers and sporogenous tissue; 15. Fibrous endothecium; 16. Transection of anther showing disorganising tapetum and middle layer, and microspore tetrads; 17. Transection of anther showing periplasmodial tapetum and uninucleate pollen grains; 18-22. Meiotic divisions in microspore mother cells; 23,24. Tetrahedral and decussate microspore tetrads respectively; 25. Uninucleate pollen grain. 26,27. Formation of two-celled pollen grain; 28. Two-celled pollen grain showing elongate generative cell; 29. Three-celled pollen grain. (arc, archesporial cell; bcap, budded capitulum; cap, capitulum; en, endothecium; ep, epidermis; ft, fibrous thickenings; gc, generative cell; ispl, inner secondary parietal layer; ml, middle layer; ospl, outer secondary parietal layer; pap, pappus; pc, periplasmodium; r, root; sp, sperms, sys, syngenesious; tp, tapetum; vg, vegetative cell).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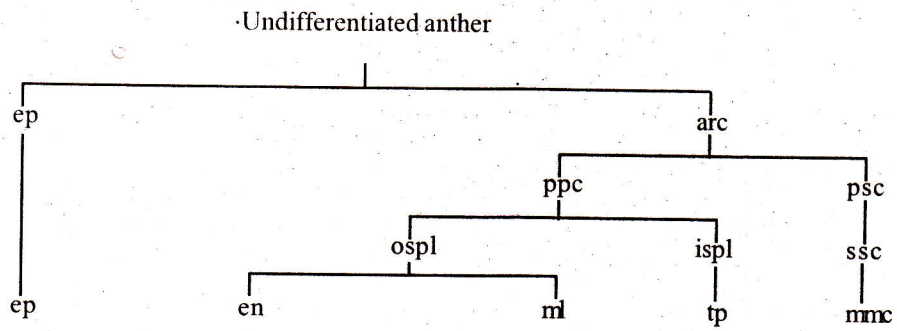
S.R. I

Schematic representation of the ontogeny of anther wall layers and meiocytes in *Grangea maderaspatana* (Linn.) Poir.



(ep, epidermis; arc, archesporium; ppc, primary parietal cell; psc, primary sporogenous cell; ospl, outer secondary parietal layer; ispl, inner secondary parietal layer; ssc, secondary sporogenous cells; en, endothecium; ml, middle layer; ta, tapetum; mmc, microspore mother cells.)

The tapetal cells, prior to meiosis in the microspore mother cells, become binucleate (Fig. 14). These cells do not, at any stage, become vacuolate. At the uninucleate stage of pollen grains, a periplasmodium is formed by the dissolution of the inner tangential walls of the tapetal cells and the gradual inwards flow of their cytoplasm along with nuclei between the developing microspores (Fig. 17). It gets absorbed by the time the pollen grains reach maturity. The anther tapetum is of the periplasmodial type.

The wall of the mature microsporangium comprises only of the epidermis and the fibrous endothecium (Figs. 15, 17). The three celled pollen grains are dispersed through two longitudinal slits in the anther wall.

The primary sporogenous cells divide once in a somewhat oblique manner soon after the formation of the parietal layer and form two rows of (ssc) the secondary sporogenous cells which mature gradually into (mmc) the microspore mother cells (Fig. 13). These cells divide in simultaneous manner (Figs. 18 - 22) and produce tetrahedral (Fig. 23), and rarely, decussate (Fig. 24) types of microspore tetrads. The cytoplasm of a microspore is dense and nonvacuolate (Fig. 25). The microspores are liberated by the dissolution of the common callose walls.

The nucleus of the young germinating microspore divides mitotically in a large vegetative and a small generative cells (Fig. 26). After pinching off from the inner layer of the wall of a microspore, the generative cell becomes spherical (Fig. 27). Rarely, elongate and uninucleate generative cells are also observed (Fig. 28). Nucleus of the generative cell divides to form two uninucleate sperms that are beseiged by thin cytoplasm (Fig. 29).

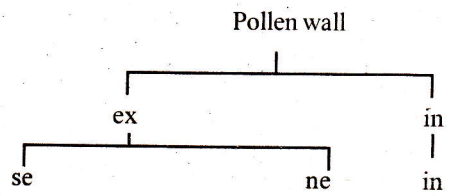
The mature pollen grain (Fig. 29) is spheroidal, three celled and triporate. The pollen wall comprises of an inner thin layer, the intine and an outer thick layer, the exine, the latter is further differentiated into a smooth nexine and a spiny sexine (See also S.R. II).

Discussion

Herbaceous nature and wild occurrence are the dominant features of Asteraceous taxa[2]. *Grangea maderaspatana* (present study) is no exception to this general rule. In accordance with the characteristic features of Asteraceae, the present study also reports a capitulum with two types of florets, white pappus, syngenesious and epipetalous

S.R. II

Schematic representation of wall layers of a pollen grain in *Grangea maderaspatana* (Linn.) Poir.



(ex, exine; in, intine; se, sexine; ne, nexine.)

stamens, inferior ovary with a single basal ovule and cypsela in *G. maderaspatana*. However the rossette habit, the profusely hairy aerial parts and the budded capitula are the interesting features of this taxon which are of rare occurrence in this family. Moreover, the presence of budded capitula in *G. maderaspatana* is a new report to the family Asteraceae. The sporodic instances of the budding of capitula in healthy plants may either be due to the increased food supply or due to some varied physiological activities occuring in such plants.

Tetrasporangiate anthers[1,3] are quite common in Asteraceae. Trisporangiate anthers[4] occur only in *Youngia japonica*. The present study finds bisporangiate anthers in *G. maderaspatana*, a condition also reported earlier in few members[5,6,7,8] of this family. As known for Asteraceae[3,8,9] the present work shows periplasmodial type of anther tapetum in *G. maderaspatana*. The secretary anther tapetum has, however, been observed in *Y. japonica*[4] and *Prenanthes brunoniana*[10]. Interestingly, *Sonchus oleraceous* records the secretary type[11] as well as the periplasmodial type[12] of anther tapetum. Both uni-, and bi-, nucleate tapetal cells are seen in *G. maderaspatana* (present work). Tapetal cells with a linear row of eight nuclei occur in *Eupatorium odoratum*[13]. Similarly, Villari[9] has reported plurinucleate tapetal cells at microsporogenesis in *Helichrysum rupestre* var. *errerae*. The possible reason for such variation may either be some nutritional factor or the spatial relationship. As true for Asteraceae[1,3,8], fibrous thickenings are found in mature endothecium of *G. maderaspatana* (present work). However, *Pluchea tomentosa*[14] lacks such feature. In conformity with earlier findings[1,3,8] for Asteraceae, archesporium possesses a single row of hypodermal cells in an anther lobe of *G. maderaspatana* (present study). Rarely, a two-layered male archesporium occurs in *Blainvillea rhomboides*[15].

The primary sporocytes function directly as pollen mother cells in *Brachychome iberidifolia*[16]. Transverse[6] and oblique[5] divisions of primary sporogenous cells also occur in this family. The investigation reveals an oblique division of primary sporocytes to form two rows of pollen mother cells in *G. maderaspatana*. In accordance with the past record for Astreraceae[1,3,8], *G. maderaspatana* (present work) indicates simultaneous cytokinesis to form tetrahedral and decussate pollen tetrads. Recently, Rozenblum *et al.*[17] advocate the abnormalities in karyokinesis and cytokinesis in microsporogenesis in *Eupatorium tanacetifolium* which result in irregular sporads formation comprising of 5-10 cells of variable size, shape and chromosome number. The present work in *G. maderaspatana* supports the earlier generalization[18] that the Asteraceae, at anthesis, have only 3 - celled pollen grains. Interestingly, anthesis has also been observed at 2-celled stage in *Emilia sonchifolia*[19] and 4-celled stage in *Senecio candicans*[20].

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References

1. Davis G L 1966, *Systematic Embryology of the Angiosperms* John Wiley and Sons, New York
2. Lawrence G H M 1951, *Taxonomy of Vascular Plants* The Mac Millan Company, New York
3. Pullaiah T 1984, *Embryology of Compositae* Today and Tomorrow's Printers and Publishers, New Delhi
4. Kaul V 1973, *Proc. 60th Indian Sci. Congr.* Part **3** 328
5. Sundara Rajan S 1974, *Proc. Indian Acad. Sci.* **B 79** 267
6. Pullaiah T 1983, *Plant Syst. Evol.* **142** 61
7. Rangaswamy V and Pullaiah T 1984, *J. Jap. Bot.* **59** 15
8. Vijayaraghavan M R and Sud K C 1998, *J. Indian bot. Soc.* **77** 103
9. Villari R 1987, *Bot. Ital.* **121** 133
10. Sood S K and Thakur T S 1984, *Proc. Indian Acad. Sci. (Plant Sci.)* **94** 553
11. Walter R and Kuta E 1971, *Acta. Biol. Cracov. Ser. Bot.* **14** 103
12. Pullaiah T 1982, *Curr. Sci.* **51** 708
13. Maheswari Devi H and Pullaiah T 1977, In: Recent trends and contacts between cytogenetic, embryology and morphology V R Dnyansagar *et al.* (eds). Today and Tomorrow's Printers and Publishers, New Delhi, p 307
14. Lalitha Ram 1986, *J. Indian Bot. Soc.* **65** 47
15. Sundara Rajan S 1972 , *Proc. Indian Acad. Sci.* **B 75** 167
16. Sharma H P and Murty Y S 1977, *J. Indian bot. Soc.* **56** 321
17. Rozenblum E, Maldonado S and Waisman C E 1988, *Amer. J, Bot.* **75** 311
18. Brewbaker J L 1967, *Amer. J. Bot.* **54** 1069
19. Sundara Rajan S 1968, *Curr. Sci.* **37** 26
20. Rangaswamy V and Pullaiah T 1986, *J. Indian Bot. Soc.* **65** 509