Observations

Genus Dipcadi Medik. is represented by about 55 species distributed in Mediterranean region, Africa, Madagascar, India, Pakistan and Nepal. So far 9 species have been described from India of which 3 are endemic to India and all endemic taxa are restricted to Maharashtra State.

Diagnostic characters of the genus Dipcadi : Tuberous scapigerous herb; bulb tunicated, outer scale scarious, inner fleshy. Leaves usually narrow, linear, radical with sheathing base, flower racemose, bracteate. Scape as long as leaves, terete, stiff with terminal raceme. Flower campanulate, tubular, tube cylindric, perianth lobes six, erect; outer perianth lobes recurved from above the middle; the inner curved at tip only. Stamen 6, inserted in the throat of the perianth and adnate to the perianth tube, free portion of filament short or zero; anther linear, versatile, dehiscing introsely. Pollen oblong, monocolpate, psilate to foveolate. Ovary stipitate or sessile with numerous ovule on axile placentation; septal nectaries present in the ovary; style linear short or long, straight; stigma 3 lobed. Capsule membranous, sub globose or obovoid, deeply 3 sulcate, sessile or stalked, loculicidally 3 valved, few to many seeded.

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Seed few to many in each cell, superposed, orbicular to round, wrinkled or obscurely winged, testa black, membranous.

Most of the species of the genus are bulbous, perennial herbs with short lived aerial shoots. The various species found in India are identified on the basis of exomorphic attributes. Even the most recent taxonomic treatment on Indian species of Dipcadi (Deb and Dasgupta, 1981) is mainly based on features such as leaf length and breadth, length of scape, number of flower in a raceme, size of flower, length of bract, nature of Pedicel, degree of fusion of filament with perianth tube etc. All these characters are quantitative and are of relative value. Some of the species found in India show great variation in external morphological attributes under different climatic and edaphic factors. Therefore, a detailed morphological studies have been made on the species of the genus growing in Maharashtra. Critical observation on exomorphic features and phenology have been made on the plants growing in natural habitats as well as on plants grown in earthern pots and plots in the botanical garden of the department. Details of the species collected and their places of collection in Maharashtra are given in Table No.2.

The distribution of species found in Maharashtra is shown in Map-I. Observations on quantitative characters of different species of Dipcadi based on plants grown in botanical garden and in natural habitats are given in Table No.3 and shown polygraphically in Text Fig. I figs. 1-6. Detailed account of morphological characters, place of collection, flowering and fruiting period, herbarium sheets deposited and observations on different species of Dipcadi found in Maharashtra is given below. The changes in quantitative characters of plants from natural habitat and grown in garden is depicted in Table.3.

A) MORPHOLOGY

(1) Dipcadi Concanense (Dalz.) Baker.

(Table No.3 , Text Fig.I figs. 2 plate I fig. 1 & 2)

Description of the species based on plants growing in natural habitats is given below.

Scapigerous bulbous herbs, 39.4 ± 7.3 cm in height; bulbs tunicated, white 1.3 ± 0.13 x 1.3 ± 0.3 cm. Leaves linear, narrow, acute, 34.9 ± 5.8 x 0.46 ± 0.05 cm. Scape erect, terate, glabrous, 35.7 ± 8.2 cm in height, basal diameter 3 ± 0.4 mm. Inflorescence loose raceme, 3 ± 1.1 flowered. Flower bracteate, bract 8 ± 0.7 x 6 ± 0.7 mm,

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deltoid, scarious, acuminate, almost as long as the pedicel or little shorter. Pedicel 8 ± 1.2 x 1.3 ± 0.2 mm, filiform. Flower long, 4.3 ± 0.5 cm in length. Perianth segment 7 to 9 nerved, shining white; outer lobe 1.8 ± 0.32 x 0.45 ± 0.05 cm, lanceolate, acute, fimbriate at tip, spreading; inner lobes 0.9 ± 0.1 x 0.4 ± 0.05 cm, curved at tip only. Stamen 6, filament adnate to tube, free portion 4 to 6 mm long, filiform, anthers 4.5 ± 0.3 x 1.2 ± 0.1 mm, dorsified introse, pollen oblong 128.5 ± 32.5 x 124.8 ± 35.9 mμ, foveolate. Gynoecium stipitate, 3.8 ± 0.4 cm, long; ovary 4.8 ± 1 x 3 ± 0.8 mm, trigonous, distinctly stipitate, style 2.9 ± 0.3 x 0.09 ± 0.02 cm; stigma trifid, papillose. Capsule stipitate, globose, 1.2 ± 0.08 x 1.2 ± 0.09 cm.Seeds 5.5 ± 0.6 x 3.9 ± 0.4 mm, compresed, shining black, round.

Flowering and fruiting - July - August.

Localities of collection - Deogad, Ratnagiri, Malwan.

Specimens deposited - S1, S2, S3 and S4

Local names - Gaimukhi.

Field note :- The species grows in open grass - lands in red gravely soil accumulated on laterite in Konkan. The species is rare in occurence but distributed in Konkan from

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PLATE - I figs. 1-4- Showing plants in earthern pots and close up of inflorescence of Dipcadi concanense and Dipcadi saxorum.

Fig. 1 - D. concanense in earthern pot.

Fig. 2 - D. concanense close up of inflorescence.

Fig. 3 - D. saxorum in earthern pot.

Fig. 4 - D. saxorum close up of inflorescence.

PLATE - II figs. 1-4 Showing plants in earthern pots and close up of inflorescence of Dipcadi montanum.

Fig. 1 and 2 - plants in earthern pots.

Fig. 3 and 4 - close up of inflorescence.

PLATE - III figs. 1 and 2 -*D. ursulae* from Panchagni plateau (Mahabaleshwar) and fig. 3 and 4 a form with large bulbs, broad leaves and long coriaceous bracts. (*D. ursulae*).

Fig. 1 - *D. ursulae* in earthern pot.

Fig. 2 - close up of part of inflorescence.

Fig. 3 - Form of *D. ursulae* with large bulbs, broad leaves and long coriaceous bracts in earthern pot.

Fig. 4 - close up of part of inflorescence of robust form of *D. ursulae.*

PLATE - IV figs. 1 and 2 D. maharashtensis (form with coriaceous bracts.)

Fig. 1 - plants in earthern pot.

Fig. 2 - close up of part of inflorescence.

PLATE - V figs. 1-8 Showing mitotic metaphase plates in root tip cells and Idiograms of Dipcadi Medik. species.

Fig. 1 - D. concanense showing 2n = 12 x 930.

Fig. 2 - D. saxorum showing 2n =12 x 930.

Fig. 3 - D. maharashtrensis (form with coriaceous bracts from Kas) showing 2n = 20 x 930.

Fig. 4 - D. ursulae (Mahableshwar) Panchagni plateau showing 2n =20 x 930.

Fig. 5 - D. montanum (Kartikiswami) showing 2n = 20 x 930.

Fig. 6 - D. ursulae (form with large bulb, broad leaves and coriaceous bracts from kas) showing 2n = 20 x 930.

Fig. 7 - D. montanum (form with narrow leaves from Panhala) showing 2n = 20 x 930.

Figs. A - D - Idiograms

A - D - D. concanense

B - D - D. saxorum

C - D - D. maharashtrensis (form with coriaceous bracts from Kas)

D - D - D. ursulae (Mahabaleshwar)

E - D - D. montanum (Kartikiswami)

F - D - D. ursulae (A form with large bulbs, broad leaves and coriaceous bracts from Kas)

G - D - D. montanum (A form with narrow leaves from Panhala)

PLATE - VI figs. 1-15 Showing meiosis in D. concanense

Fig. 1 - showing pachytene x 800

Fig. 2 - Diakinesis with 6 bivalents and nucleolus x 800

Fig. 3 and 4 -Diakinesis showing nucleolus associated with two long chromosomes and one short chromosome x 800

Fig. 5-7- Diakinesis showing association of bivalents with nucleolus x 800.

Fig. 8 - Diakinesis with abnormal association of bivalents x 800.

Fig. 9 - clumped bivalents at diakinesis x 800

Fig. 10 and 11 -Diakinesis with unequal abnormal orientation x 800

Fig. 12 - unequal grouping of bivalents x 800

Fig. 13 - Diakinesis x 800.

Fig. 14 - Irregular distribution of bivalents x 320

Fig. 15 - Anaphase I x 320.

PLATE - VII figs. 1 to 12 Showing meiosis in D. saxorum

Fig. 1 - Diakinesis showing 6 bivalents with nucleolus x 835

Fig. 2 - Association of nucleolus with bivalents x 835

Fig. 3 - Early metaphase with 6 bivalents x 835

Fig. 4-6- Metaphase I with different orientation, single bivalent showing typical behaviour x 1607

Fig. 7 and 8 Anaphase I early and late x 1607

Fig. 9 - Anaphase I x 835

Fig. 10 - Anaphase with Lagards x 835

Fig. 11 - Metaphase II x 1607

Fig. 12 - Metaphase II with irregular orientation x 835

PLATE - VIII figs. 1 to 5 Showing meiosis in *D. ursulae* and figs. 6 to 9 in *D. montanum*

Fig. 1-5 - *D. ursulae* (Robust form from Kas)

Fig. 1 and 2 - Diakinesis with two nucleoli x 806

Fig. 3 and 4 - Association of nucleoli with bivalents x 806

Fig. 5 - Irregular orientation of bivalent at diakinesis x 260

Fig. 6 to 9 - *D. montanum* (Panhala)

Fig. 6 - Metaphase I with clumped and Anaphase I with abnormal segregation x 806

Fig. 7-9 - Diakinesis showing groups of bivalents x 325

PLATE - IX. Showing anatomical characters of scape, pedicel, leaf and cuticle of various Dipcadi species from Maharashtra.

Fig. 1 - Transection of scape of D. saxorum x 170.

Fig. 2 - Transection of pedicel of D. saxorum x 170

Fig. 3 - Transection of leaf of D. saxorum x 60

Fig. 4 - Cuticle of D. saxorum x 75

PLATE X figs. 1 - 10 Showing microsporogenesis in D. concanense

Fig. 1 - T.S. of young anther showinng parietal layers and primary sporogenous cell x 170

Fig. 2 - T.S. of young anther showing epidermis, endothecium, middle layer, tapetal layer and sporogenous tissue x 170

Fig. 3 - Showing distinct tapetal layer x 170

Fig. 4,5 and 7 showing stages of meiosis in PMCS and binucleate cells of tapetum x 170

Fig. 8 - showing degenerating tapetum, pollen tetrads and young pollens x 170

Fig. 9 and 10 T.S. of mature anther showing prominent endothecium and foveolate large pollens x 170

PLATE - XI figs. 1 - 12 Showing megasporogenesis in D. concanense.

Fig. 1 - Archesporial cell x 170

Fig. 2 and 3 Parietal cell and megaspore mother cell x 170

Fig. 4 and 5 Enlarging megaspore mother cell and initiation of inner integument x 170

Fig. 6 - MMC at metaphase I and initiation of outer integument x 170.

Fig. 7 - Dyad x 170

Fig. 8 and 9 Linear tetrad of 4 megaspores x 170

Fig. 10 and 12 - Note lower chalazal megaspore enlarging and micropylar getting degenerated x 170

PLATE - XII figs. 1-9 Showing stages in development of female gametophyte.

Fig. 1 and 4 - Binucleate embryo sac x 170

Fig. 5 and 7 - Four nucleate embryo sac x 170

Fig. 8 - Young eight nucleate embryo sac x 170

Fig. 9 - Mature embryo sac showing 2 synergids, one egg, one secondary nucleus and three antipodals x 170

PLATE - XIII figs. 1 - 8 Showing some stages in development of embryo.

Fig. 1 - Zygote and layer of nucellus with starch grains x 345

Fig. 2 and 3 - Zygote and persistant pollen tube x 345

Fig. 4 - Three celled embryo with persistant pollen tube x 345

Fig. 5 - Four celled embryo x 345

Fig. 6 and 7 - Showing globular embryo x 345

Fig. 8 - Showing nucellar layer with starch grains and still persisting pollen tube x 345

PLATE - IV

PLATE - I

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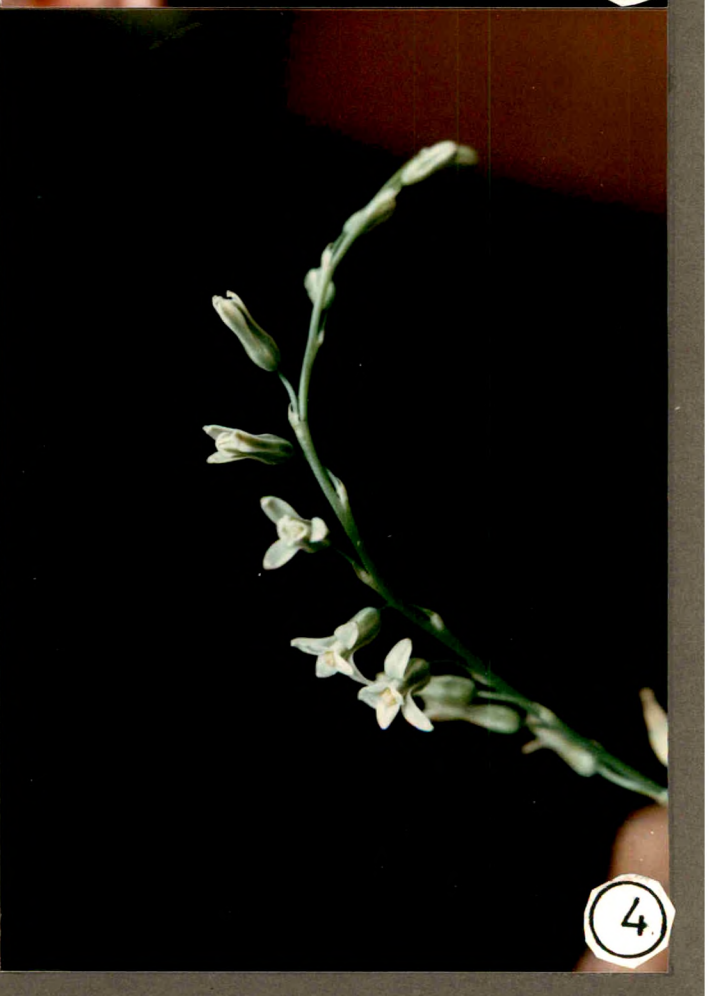

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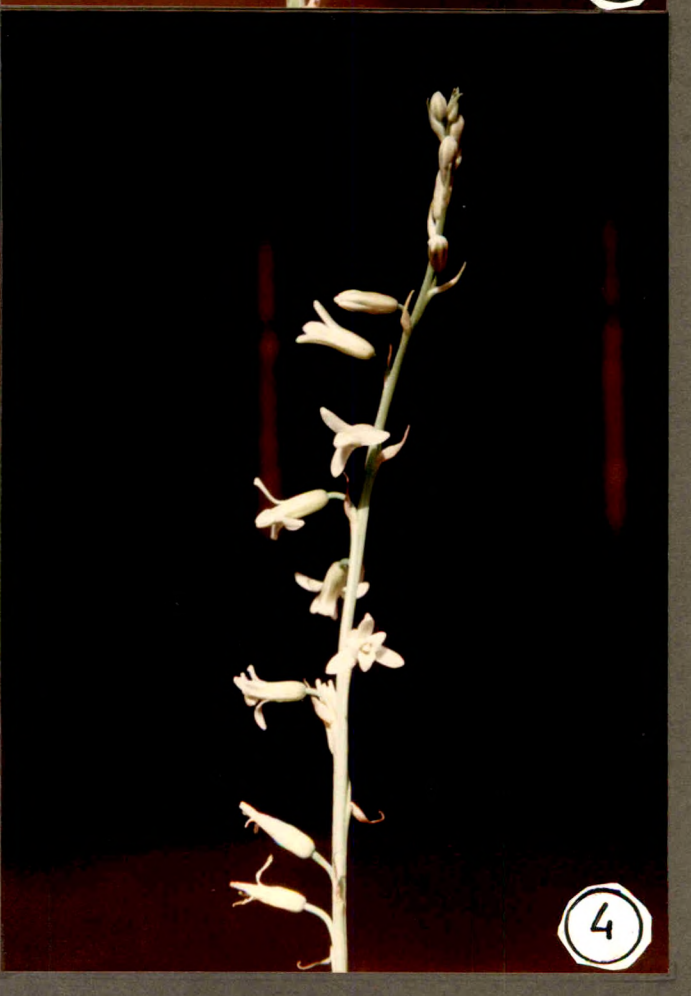
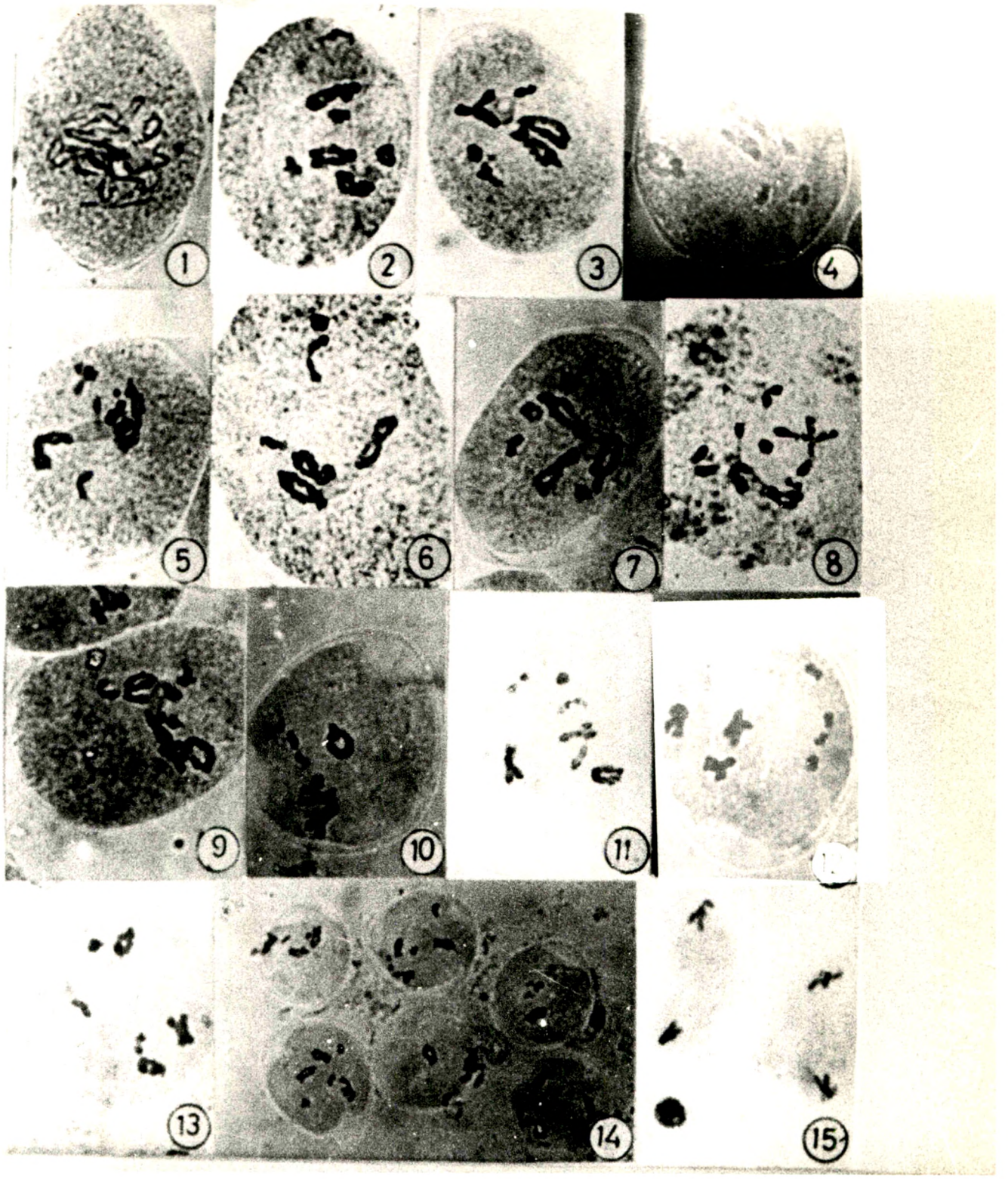


PLATE - III

PLATE – V

PLATE - VI



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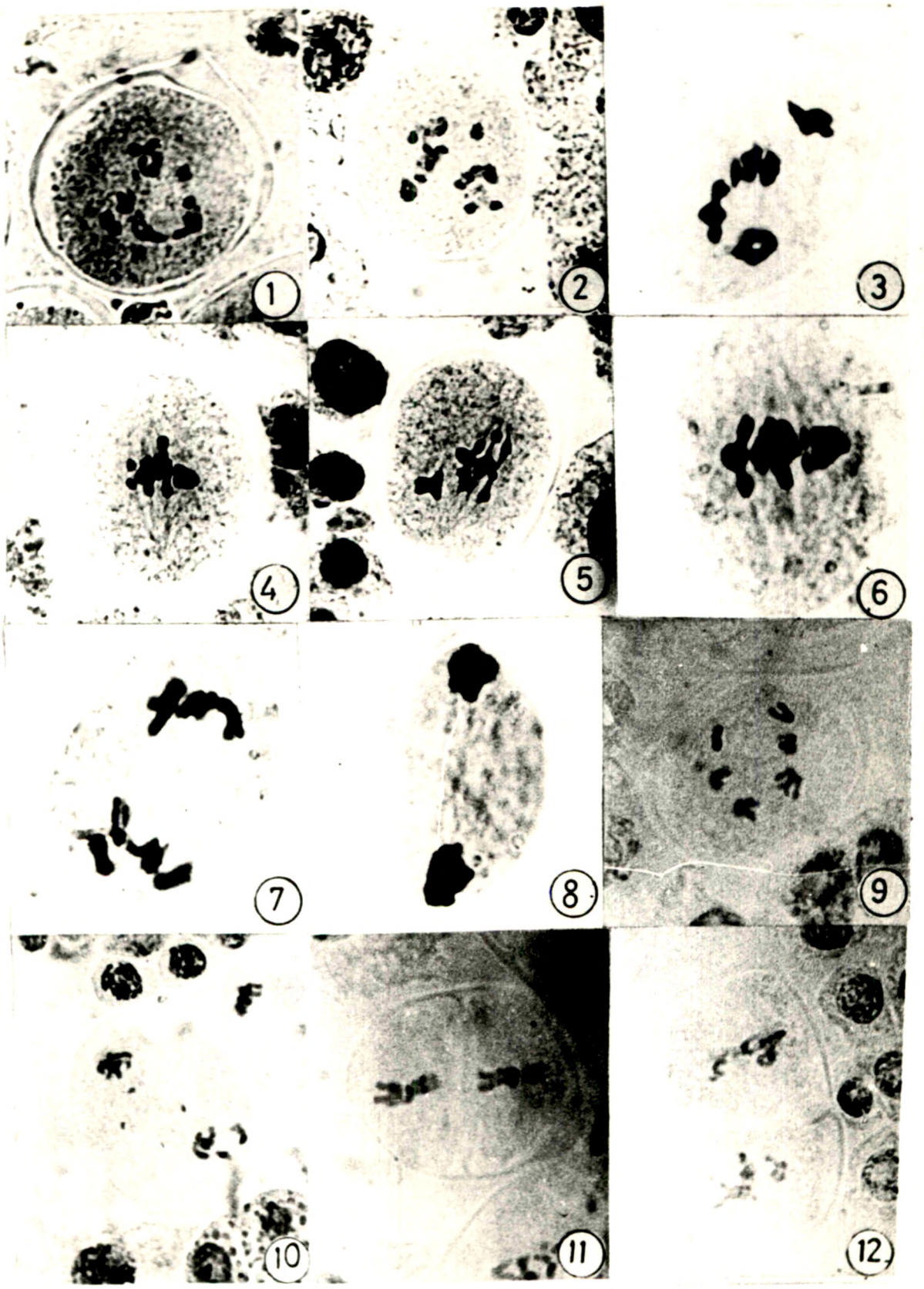

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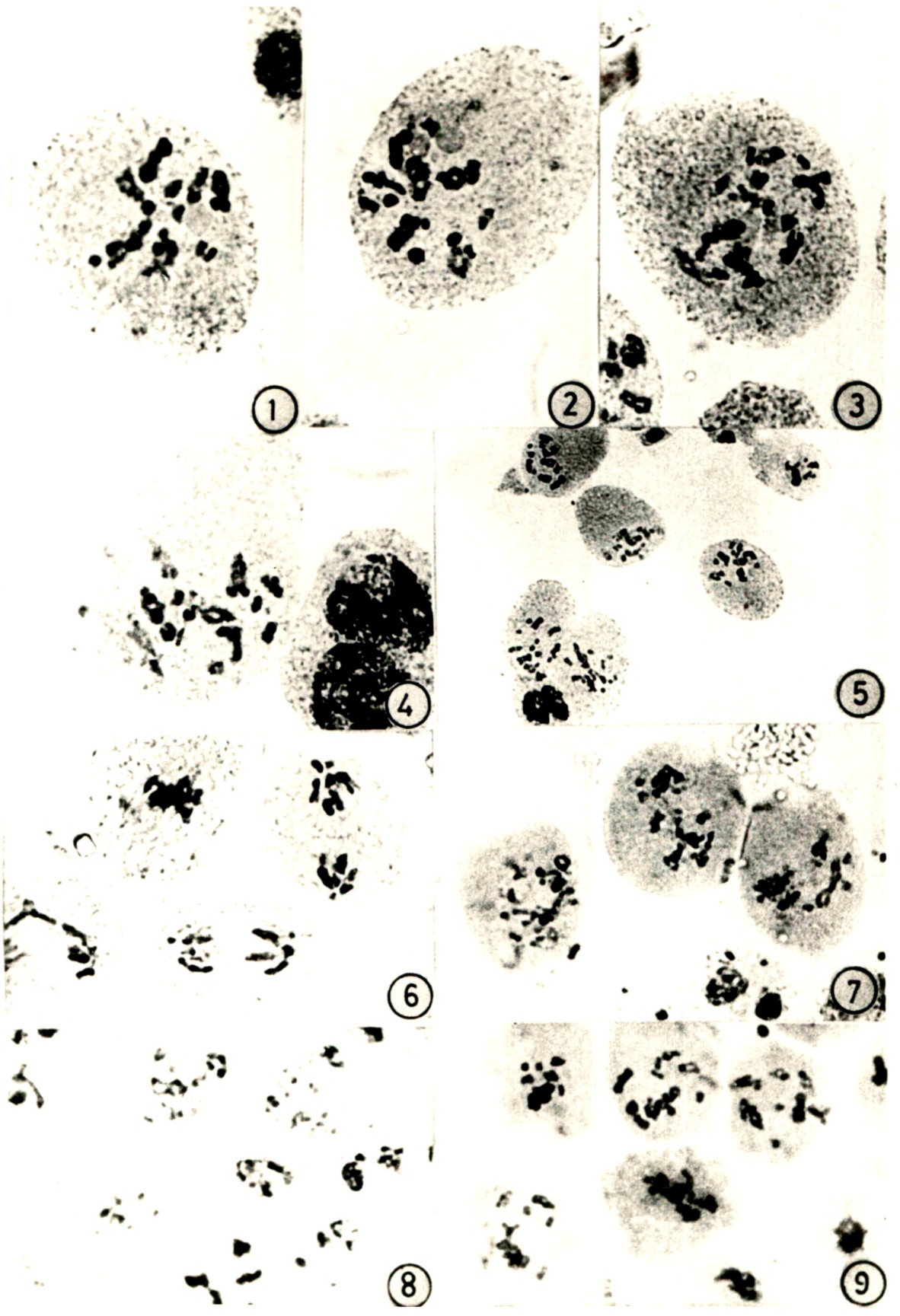

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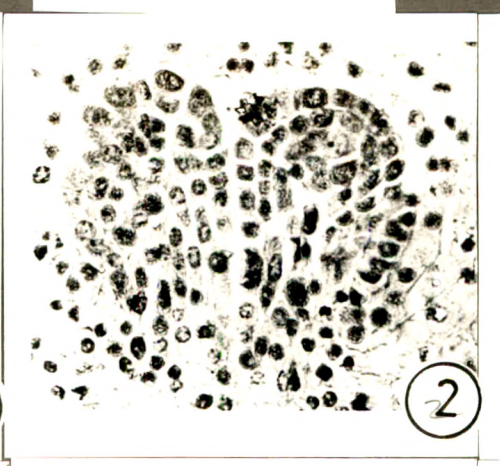

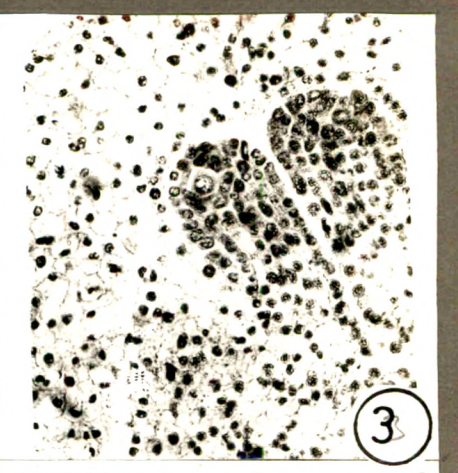

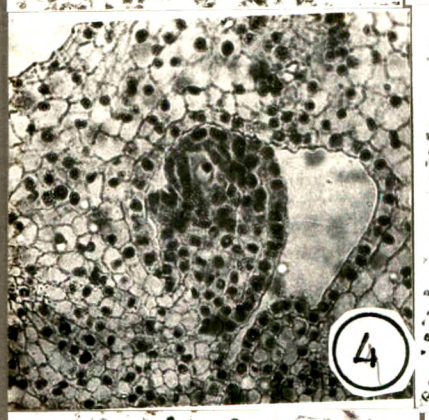

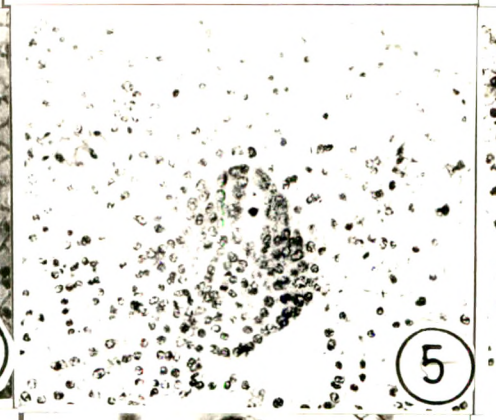

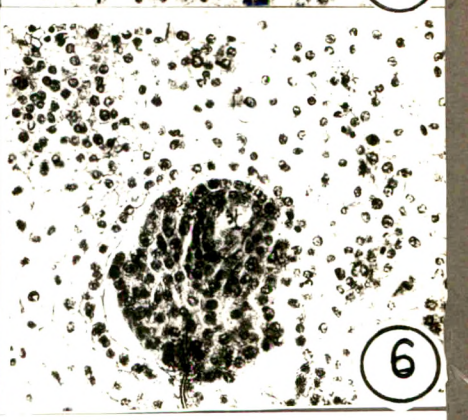

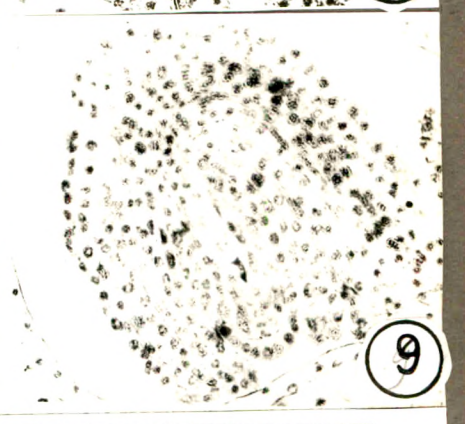

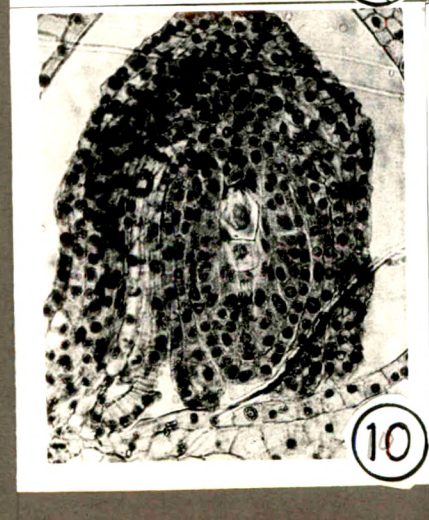

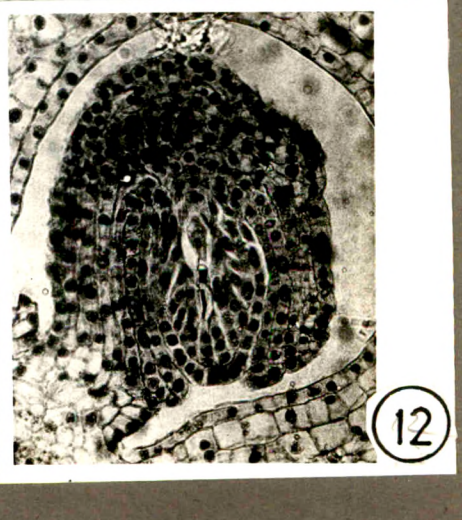

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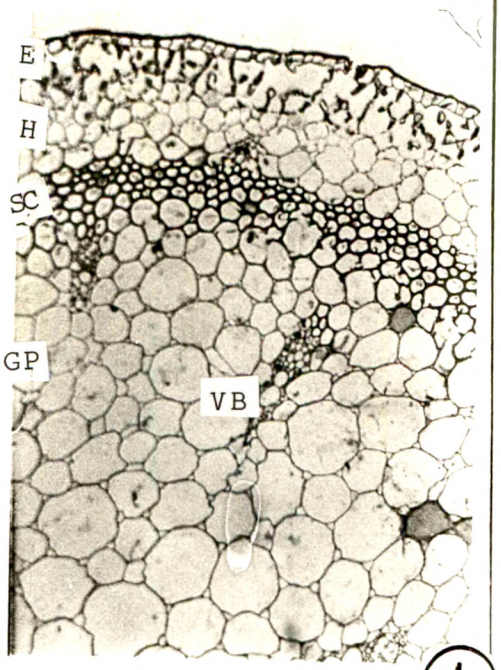

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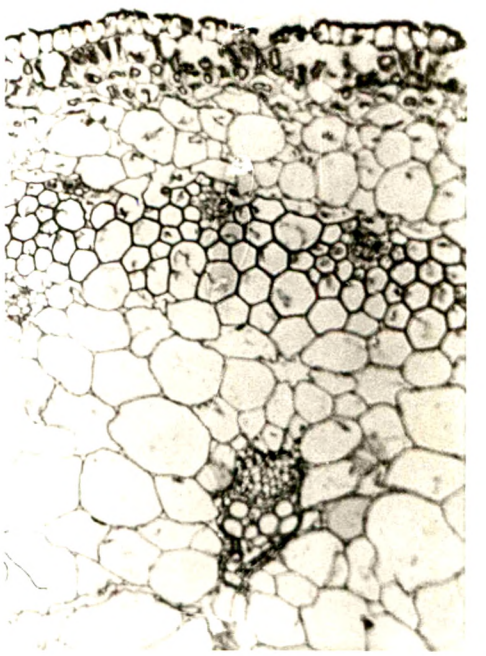

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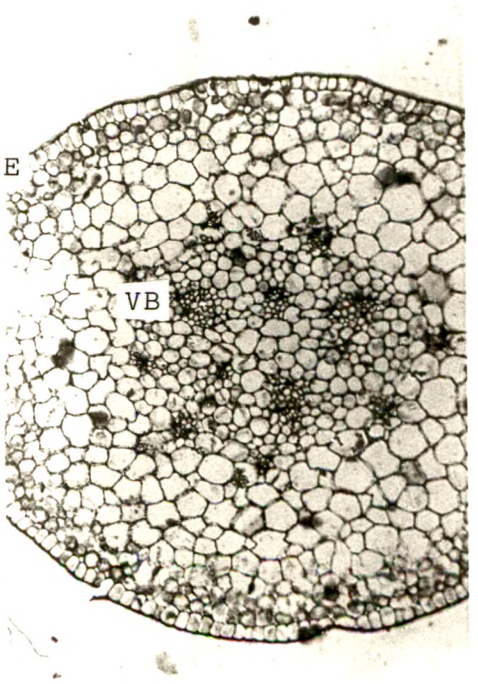

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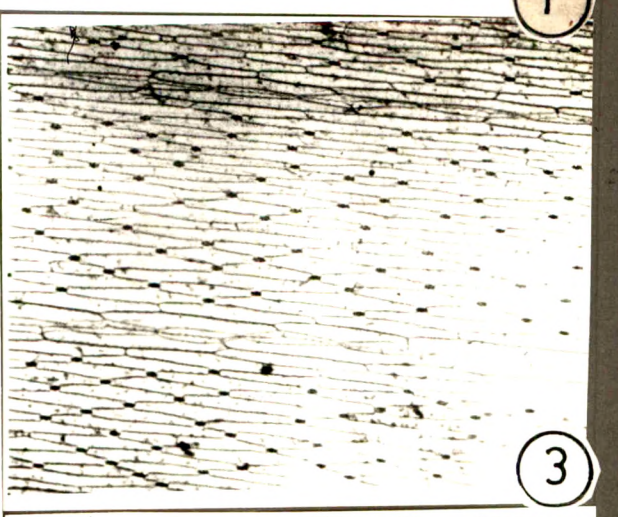

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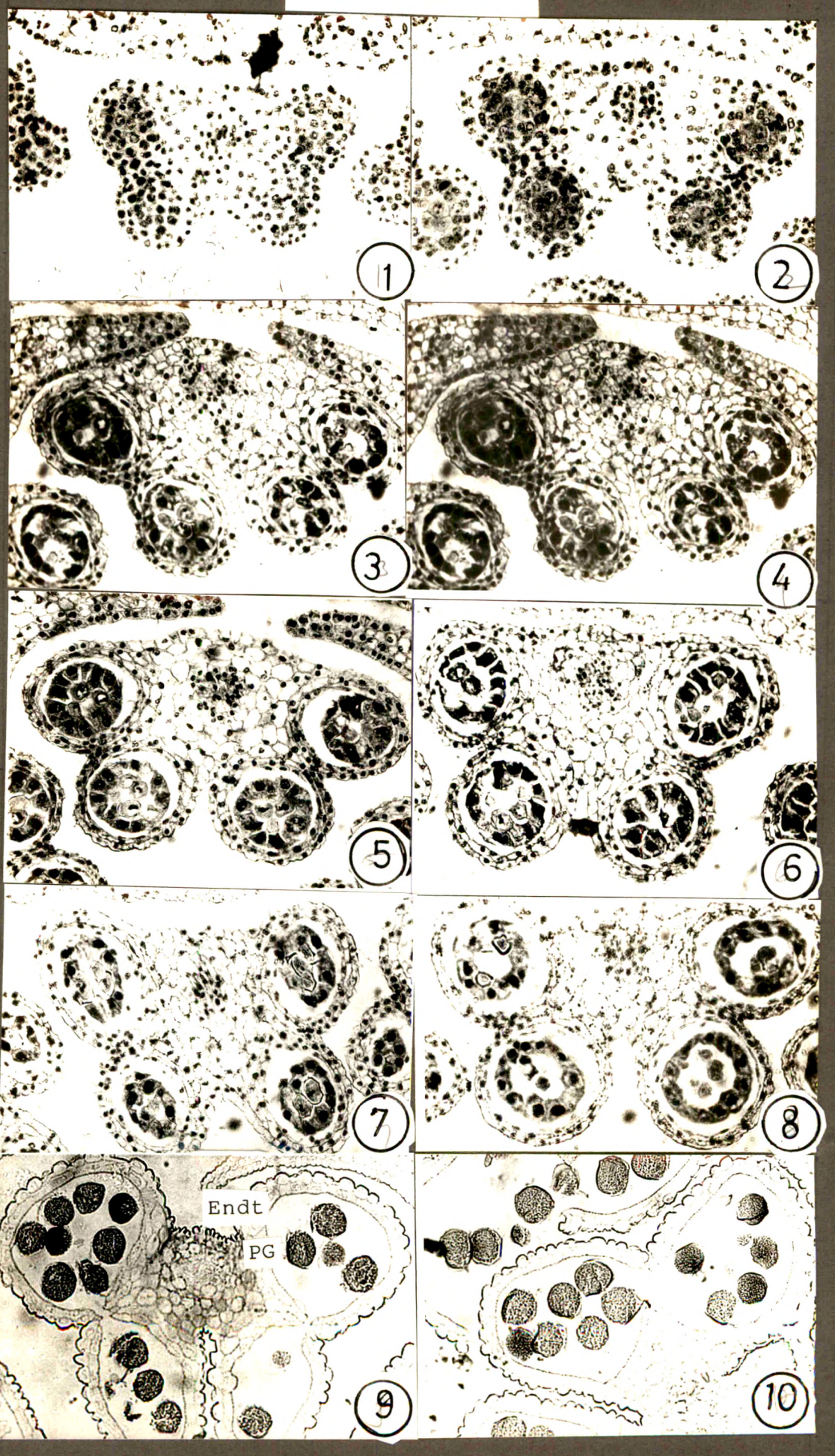

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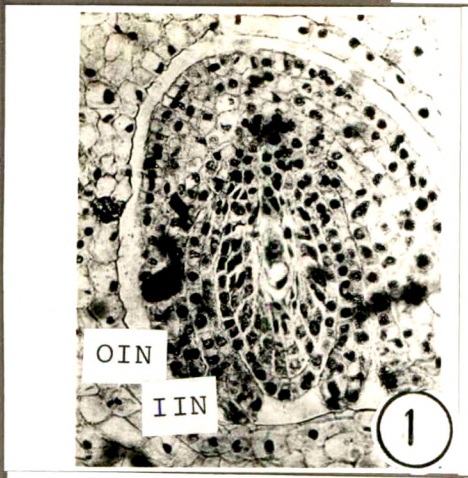

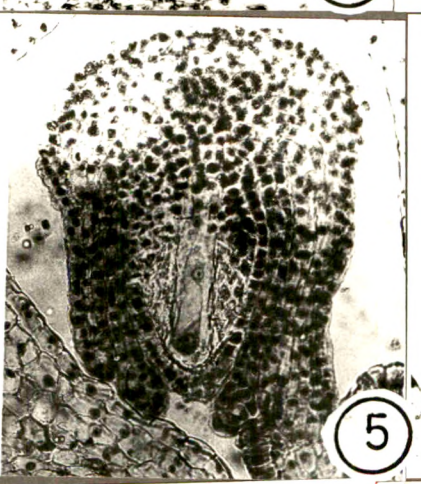

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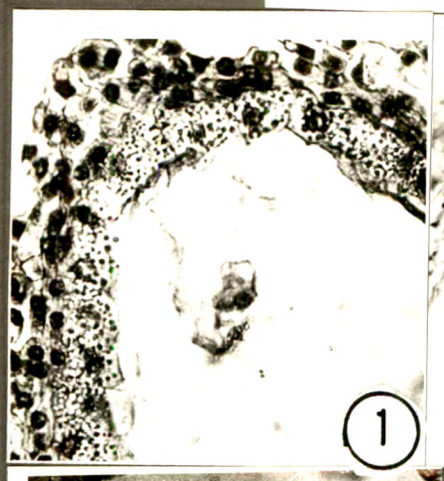
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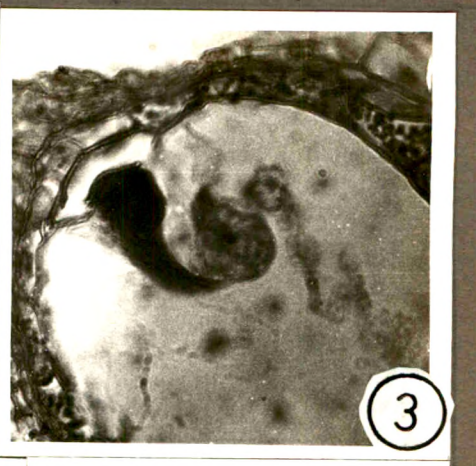
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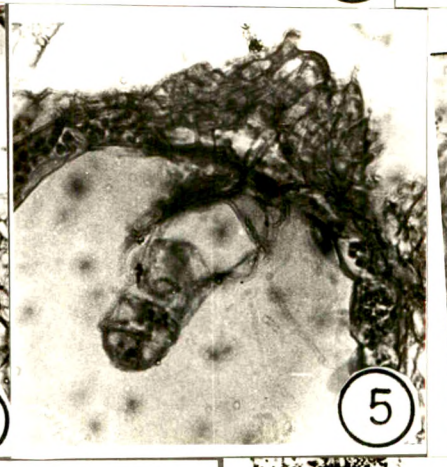
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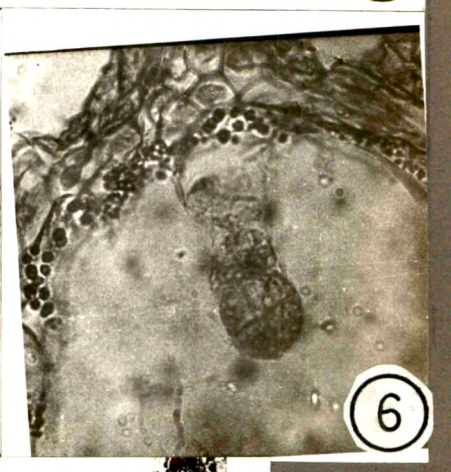
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Ratnagiri to Malwan(very low altitutde). The seeds of the species are non-dormant and germinate soon after dispersal from capsule. They form small bulbs in same season and survive in form of bulbs. The seeds loose their viability and germinability within 3-4 months. The species has got large beautifully shining white flowers. It is locally called as Gaimukhi. Among Indian species, it has got longest flowers. It is rare in occurence and needs conservation. It is endemic to Maharashtra.

Changes in measurement of various vegetative, flower and fruit attributes in plants cultivated in botanical garden and earthern pots are given in Table No.3 and shown in Text Fig. I fig. 2. From the studies it seems that species is rigid and show less changes in phenotypic characters under different climatic and edaphic condition.

(2) Dipcadi saxorum Blatt.

(Table No.3, Text Fig. I figs. 3 plate I figs. 3 & 4)

Description of the species based on plants growing in natural habitats.

Scapigerous bulbous herbs, 33.3 $\pm$ 0.8 cm in height;

bulb tunicated, white, 1.4 ± 0.4 x 1.3 ± 0.3 cm. Leaves linear, glabrous, acute, 19 ± 2.6 x 0.43 ± 0.36 cm in height, basal diameter 2 ± 0.4 mm. Inflorescence loose raceme, 9 ± 3 flowered. Flowers bracteate; bracts 5.4 ± 1.1 x 2.3 ± 1.3 mm, broadly ovate, long acuminate, scarious, shorter than pedicel; pedicel filiform 8.1 ± 1 x 0.7 ± 1.2 mm. Flowers greenish white, 1.7 ± 0.16 cm in length, salvar shaped, tubular; the outer perianth lobe connate for 1/3 their length, linear oblong, 1.2 ± 0.12 x 2.3 ± 0.2 cm, recurved from about the middle with a thick glandular tip; the 3 inner perianth lobes connate for almost 2/3 their length, 0.74 ± 0.11 x 0.21 ± 0.02 mm, ovate obtuse, with a recurved and slightly thickned tips, both outer and inner perianth lobes 3-5 nerved. Stamen 6; filament adnate to perianth tube, free filament length 2.4 ± 0.22 mm, filiform; anthers 2.2 ± 0.3 x 0.7 ± 0.5 mm, dorsifixed, introse. Pollen oblong, 85.6 ± 14.8 x 83.1 ± 1.6 mu. Gynoecium 1 ± 0.1 cm long, stipitate; ovary 3.7 ± 0.4 x 2 ± 0.2 mm, trigonous, clavate, slightly but distinctly stipitate; style 4.4 ± 0.3 x 0.7 ± 0.2 mm; stigma trilobed, papillose. Capsule stipitate, 1 ± 0.08x 1.03 ± 0.011 cm, slightly broader than long, deeply 3 sulcate loc ulicidally 3 valved membranous. Seeds 5.1 ± 1.3 x 4.3 ± 1 mm, slightly elliptical to nearly orbicular, compresed with raised margin, black.

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Flowering and fruiting - July-August.

Locality of collection - Rocky places of Kaneri caves.

Herbarium sheets deposited - S5, S6 and S7

Field note :- It is very rare species known only from its type locality. It grows in open grassland above Kaneri caves at an altitude of about 300 meters in soils accumulated on laterite. It is endemic to Maharashtra and needs conservation. The seeds are non-dormant and germinate soon after their dispersal.

Changes in measurable character of D. saxorum under garden condition and in earthern pots are given in table 3 and shown in Text Fig. I fig. 3. From these observation it is clear that the species show plasticity and increase in measurable characters under improved climatic and edaphic factors.

(3) Dipcadi montanum (Dalz.) Baker.

(Table No.3, Text Fig.I Fig, 4 plate II fig. 1-5).

Description based on plants growing in natural habitats.

Scapigerous bulbous herbs, 34.4 ± 5.3 cm in height; bulbs tunicated, white, 2.6 ± 0.44 x 1.6 ± 0.26 cm, ovoid. Leaves linear, narrow, acute, 27.6 ± 9.1 x 0.6 ± 0.12 cm, glabrous. Scape erect, terete, glabrous, 28.7 ± 5.2 cm in height, basal diameter 2.4 ± 0.46 mm. Inflorescence 12.8 ± 4.4 cm long, raceme, 11.5 ± 1.8 flowered. Flower bracteate; bract 1.3 ± 0.12 x 0.5 ± 0.12 cm, as long as pedicel or longer, lanceolate or ovate acuminate, scarious; pedicel filiform, 10 ± 0.13 x 0.65 ± 0.1 mm. Flower 2.16 ± 0.13 cm in length, salvar shaped; perianth segment 6; outer longer, united upto 1/3 from the base, campanulate, lobes lanceolate, 1.4 ± 0.1 x 0.32 ± 0.07 cm; inner perianth lobes united upto 2/3 from the base, tubular, lobes 1.3 ± 0.6 x 0.3 ± 0.03 cm, tips recurved at apex, obtuse, thickned at apex, perianth white, some time greenish. Stamen 6, inserted at the throat of the tube; filament adherent along the perianth throughout the tube; free filament 3 ± 1 mm; anther 2.3 ± 0.12 x 0.6 ± 0.08 mm, linear oblong, versatile, introse. Pollen 94 ± 13.84 x 97 ± 11.5 mu, foveolate. Gynoecium 1.1 ± 0.1 cm long; ovary 4.4 ± 0.8 x 2.3 ± 0.13 mm, stipitate, narrowly obovate oblong; septal nectaries present; style 4.7 ± 0.21 x 0.8 ± 0.15 mm, linear; stigma trilobed, papillose.

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Capsule stipitate, globose 1.1 ± 0.1 x 1.2 ± 0.1 cm, broader than long, narrowed at base, obovoid, deeply trilobed, membranous. Seeds 3-5 in each locule, 5.1 ± 0.6 x 5.2 ± 0.6 mm, Orbicular, compressed, narrowly winged, black, glossy.

Flowering and fruiting - July-August.

Localities of collection - Panhala, Kas, Mahabaleshwar, Kartikiswami.

Herbarium sheets deposited - S8, S9 and S10

Field Note :- The species grows in open grassland on plateaus of Sahydri at an higher altitude. It is wide spread in Maharashtra. It shows great variation under different climatic and edaphic factors. The seeds germinate soon after dispersal and survive in the form of small bulbs. Changes in measurement of various vegetative, flower and fruit attributes in plants cultivated in earthern pots and in botanical garden are given in Table No.3 and shown in Text Fig.I fig..4.

(4) Dipcadi montanum (Dalz.) Baker.
(Form with narrow leaves).

(Table No.3, Text Fig.I, Fig. 4)

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Description based on small plants with narrows leaves isolated from populations collected from Panhala, Kas plateau and Mahabaleshwar and cultivated in botanical garden.

Scapigerous bulbous herbs, 23.5 ± 3.6 cm in height. Bulbs small, tunicated, 2.6 ± 0.4 x 2 ± 0.3 cm. Leaves narrow, glabrous, acute, 33.3 ± 3.5 x 0.4 ± 0.13 cm. Scape erect, terete, glabrous, 34 ± 4 cm in height, basal diameter 2.7 ± 0.4 mm. Inflorescence loose raceme, 11.6 ± 6 cm long, 14 ± 2 flowered. Flowers bracteate; bracts 1.4 ± 0.22 x 0.45 ± 0.1 cm, scarious, caducous, acute longer than pedicel; pedicel 7 ± 1 x 0.6 ± 0.1 mm, filiform. Flower 1.8 ± 0.3 cm long; outer perianth united 1/3; outer perianth tube 0.45 ± 0.05 cm long, perianth lobes 1.4 ± 0.04 x 0.3 ± 0.03 cm; inner perianth lobes united upto 2/3; tube 1.04 ± 0.05 cm long, perinath lobes 0.7 ± 0.07 x 0.3 ± 0.03 cm; perianth lobes of both whorls 6-7 nerved. Stamen 6, adnate to the perianth tube, free filament 3.7 ± 0.27 mm long; anther 3 ± 0.14 x 0.7 ± 0.3 mm dorsifixed, versatile, introse. Pollen 73 ± 28.3 x 69 ± 25.8 mu; psilate to foveolate stipitate, 5.7 ± 0.4 x 2.3 ± 0.2 mm, trigonous; style 5.2 ± 0.4 x 0.9 ± 0.05 mm; linear, slender, stigma trilobed.

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Flowering and fruiting - June to August.

Localities of collection - Panhala, Kas, Mahabaleshwar.

Herbarium sheets deposited -S11 and S12.

Field note :- The plants show smaller size in all respect even under cultivation. It shows characters of D.montanum. Flowering and fruiting is little late than other populations of D. montanum.

(5) Dipcadi ursulae Blatt.

(Table No.3 Text Fig. I fig. 5 Plate - III fig. 1 & 2)

Description based on plants selected from population of Mahabaleshwar grown in botanical garden and earthern pots.

Scapigerous, bulbous, robust herbs, 55.4 ± 6.7 cm in height; bulb large, globose, 3.2 ± 0.64 x 2.6 ± 0.4 cm. Leaves linear, flat, 55 ± 9.5 x 1.5 ± 0.3 cm, grass green, sheathing at base, glabrous. Scape erect, terete, glabrous, 45.4 ± 10.4 cm in height, basal diameter 4.3 ± 1.1 mm. Inflorescence comparatively dense raceme, 22 ± 3 flowered, 17.3 ± 6.5 cm long. Flower bracteate; bracts scarious,

caducous, ovate, long acuminate, 1.8 ± 0.4 x 0.7 ± 0.1 mm, much longer than the pedicel; pedicel 1± 0.3 x 0.11 ± 0.03 mm, stout. Flower 1.9 ± 0.3 cm long, white to pale cream or orange coloured; outer perianth tube short, 0.47 ± 0.04 cm long perianth lobes 1.4 ± 0.14 x 4.1 ✦ 0.2 cm; inner perianth tube 1.1 ± 0.08 cm long, perianth lobes 0.9 ± 0.13 x 0.4 ± 0.3 cm, recurved and thickned at apex, both inner and outer perianth 6-7 nerved. Stamen 6, adherent to the perianth tube, free filament portion 3-8 ± 0.5 mm long anther 2.5 ± 0.5 x 0.8 ± 0.1 mm, oblong or linear - oblong, dorsifixed, introse, dehiscing longitudinally. Pollen 98 ± 9.18 x 93 ± 9.90 mu, cblong, foveolate. Gynoecium 1.1 ± 0.12 cm long; ovary stipitate, 5.1 ± 2.7 x 2.7 ± 0.27 mm, narrowly obovoid oblong, trigonous, conspicuous; septal nectaries present; style 5 ± 0.8 x 2 ± 0.9 mm, stout or filiform, linear; stigma trifid, papillose. Capsule stipitate, 1.16 ± 0.15 x 1.11 ± 0.12 cm, almost as long as broad, bracts persistant to fruits. Seeds 5.2 ± 0.7 x 4 ± 0.7 mm, semi orbicular, compresed, glossy, black.

Flowering and fruiting - June-August.

Localities of collection - Mahabaleshwar, Kas.

Herbarium sheets deposited - S13, S14.

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Field note :- It grows at higheraltitude mixed with Dipcadi montanum. It becomes very difficult to differentiate it form D. montanum even when plant of both species are grown side by side. Even under cultivation it goes difficult to distinguish D. ursulae from D. montanum and all intermediate forms between these species are found. Therefore, there is need to reconsider it specific status.

(6) Dipcadi ursulae

(A form with large bulbs , broad leaves and long coriaceous bracts showing intermediate characters between D. ursulae and D. maharashtrensis)

(Table No.3, Text Fig.I, fig. 7 plate III fig. 3 & 4)

Description based on plants isolated from population of Kas plateau and cultivated in botanical garden.

Tuberous, scapigerous herbs, 59 ± 7.4 in height; bulb tunicated, white 3.6 ± 0.5 x 3 ± 0.5 cm. Leaves broad, linear, green, glabrous, 51 ± 7 x 1.3 ± 0.24 cm. Scape erect, terete, glabrous, 52.8 ± 5 cm in height, basal diameter 3.3 ± 0.3 mm. Inflorescence compact in young stage, loose raceme when mature, 22 ± 2 flowered, 31.8 ± 5 cm in height. Flower bracteate; bracts 2.2 ± 0.6 x 0.7 ± 0.08 cm,

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coriaceous, accuminate longer than the pedicel; pedicel 1.03± 0.26 x 0.8 ± 0.18 cm stout. Flower 2.01 cm in length; outer perianth united for 1/3 of their length, tube 0.6 ± 0.05 cm, perianth lobe 1.5 ± 0.12 x 0.44 ± 0.03 cm; inner tube 1.1 ± 0.06 cm long, inner perianth lobes 0.9 ± 0.1 x 0.3 ± 0.2 cm, both perianth lobes of inner and outer whorl 7 nerved, thickned at tip. Stamen 6, adnate to the perianth tube, free filament 3 ± 0.3 mm long, anther 2.7 ± 0.4 x 0.7 ± 0.2 mm, dorsifixed introse. Pollen 97 ± 12.5 x 90 ± 10.3 mu, oblong, foveolate. Gynoecium 1.2 ± 0.1 cm long; ovary stipitate, 5.3 ± 0.4 x 3 ± 0.3 mm, trigonous; style 5.5 ± 0.4 x 0.94 ± 0.05 mm, stout; strigma trilobed. Capsule 1.01± 0.14 x 1.02 ± 0.12 cm, globose. Seeds 5 ± 1 x 4 ± 0.7 mm, semi orbicular, black, compressed.

Flowering and fruiting - July-August.

Localities of Collection - Kas, Mahabaleshwar.

Herbarium sheets deposted - S15 and S16.

Note :- The form differs from D.ursulae and D. maharashtrensis in its giagantic size and show characters similar to D. ursulae but have coriaceous long bracts like D. maharashtrensis.

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(7) Dipcadi maharashtrensis Deb et. Dasgupta.

(A form with coriaceous bracts)

(Table No.3 Text Fig.I fig.6 plate IV fig. 1 & 2)

Description of the taxon is based on the plants with coriaceous bracts isolated from populations of Dipcadi collected from Mahabaleshwar and Kas plateau and grown in earthern pots and plots in botanical garden.

Scapigerous, bulbous, rather robust herbs, 68 ± 5.6 cm in height. Bulb globose, 3 ± 0.5 x 2.7 ± 0.6 cm, tunicated. Leaves radical, 47.3 ± 9.5 x 1.2 ± 0.1 cm, shorter than scape, linear, entire, acute, sheathing at base, coriaceous, glabrous. Scape 61 ± 9.6 cm in length, terete, stout, glabrous, basal diameter 4.8 ± 0.6 mm. Inflorescence comparitively compact when young, 28 ± 4 flowered, 39 ± 5.2 cm long when mature. Flower bracteate; bract coriaceous, persistant, 3.4 ± 1.5 x 0.7 ± 0.14 cm, entire, subulate, much longer than pedicel; pedicel 1.2 ± 0.31 x 0.1 ± 0.14 cm, stout, terete. Flower 2.1 ± 0.26 cm long, outer perianth tube 0.5 ± 0.1 cm, outer perianth lobes 1.33 ± 0.3 x 0.4 ± 0.3 cm, obovate lanceolate, Obtuse, thickened at the sub apex. Stamen 6, adnate to the perianth, free filament portion 3.5 ± 0.3 mm long; anthers 2 ± 0.2 x 0.8 ± 0.1 mm, dorsifixed, introse, dehiscing longitudinally.

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Gynoecium 1.2 ± 0.07 cm long, ovary stipitate, 5.1 ± 0.4 x 2.3 ± 0.14 mm broadly oblong, glabrous. Style 5.5 0.4 x 0.9 ± 0.08 mm, stout; stigma trilobed. Capsule stipitate, 1.12 ± 0.07 x 1.04 ± 0.08 cm, as broad as long, bract coriaceous persistant with fruits. Seeds 5.1 ± 0.9x 4 ± 0.8 mm, semi orbicular,black, compressed.

Flowering and fruiting - August-September.

Localities of collection - Mahabaleshwar, Kas.

Herbarium sheet deposited - S17, S18 and S19.

Note :- It resembles with D. ursulae in its robust nature and long bracts but differ in having coriaceous bracts. The species is based on single herbarium sheet collected by Rukmini Bai (B.R. 433). It is true that some plants with coriaceous bracts do occur in populations at Mahabaleshwar and Kas plateau. It easily crosses with D. ursulae (tried in botanical garden) and produces fruits with viable seeds. Observation in field and cultivation doubt its identify as separate species. It is simply variant of D.ursulae or D. montanum.

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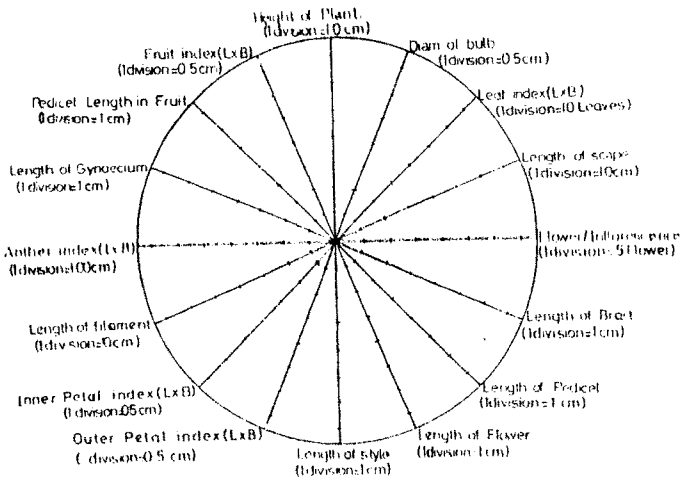
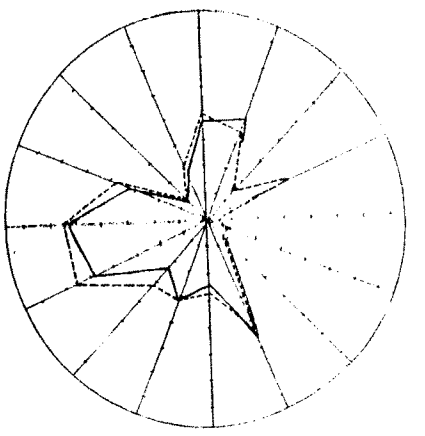
Text Figs. I figs. 1 - 6

Showing key diagram to the polygraphs and polygraphs of wild and cultivation plants of different species of Dipcadi growing in Maharashtra.

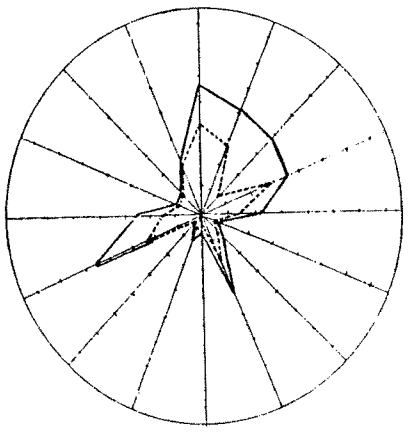
TEXT FIG - I



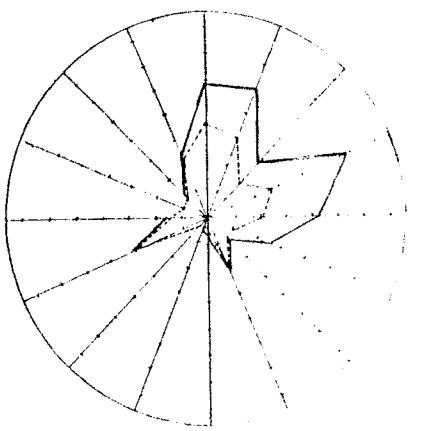
(1) KEY DIAGRAM OF THE POLYGRAPH



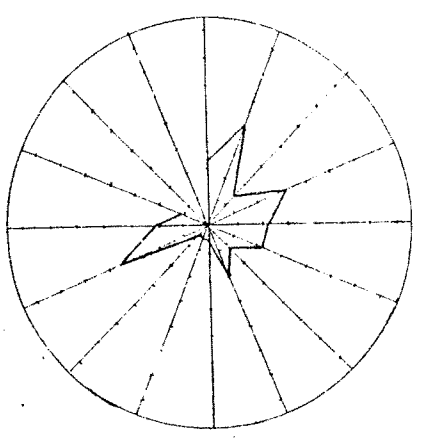
(2) D. CONCANENSE (RATNAGIR



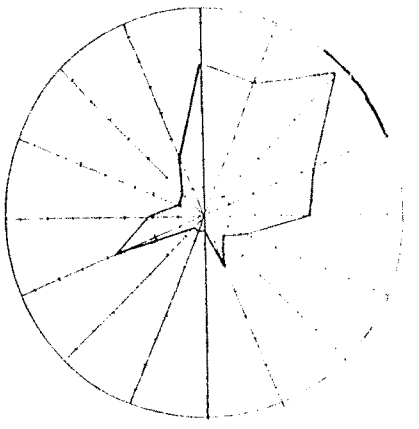
(3) D. SAXORUM (KANHARI-CAVES)



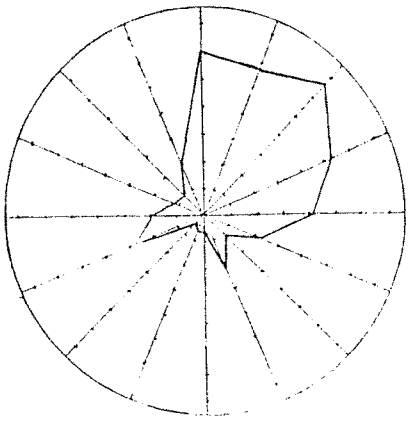
(4) D. MONTANUM (KAS-PLATEAU)



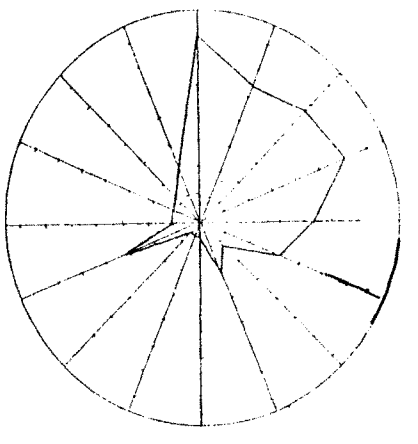
(5) D. MONTANUM (NARROW LEAVED FORM)



(6) D. URSULAE (PANCHGANI-PLATEAU)



(7) D.URSULAE (ROBUST FORM)



D. MAHARASHRENSIS (KARTIKISWAMI)

B) CYTOLOGY

All the species of Dipcadi under investigation were diploids showing 2n = 12 in D.concanense (Plate II fig.1) D. saxorum (Plate V fig.2) and 2n = 20 in D. montanum (Plate V fig. 5), D. ursulae (Plate V fig.4), D. ursulae with large bulbs, broad leaves and coriaceous bracts (Plate V fig.6), D. maharashtrensisaform with coriaceous bracts (Plate V fig.3) and D. montanum with narrow leaves (Plate V fig.7).

Chromosomes were in general of two distinct types viz. long and short giving bimodal form of Karyotype and are categorised as follows :

Type A : Very long chromosome (6.5 - 8 mu) with constriction in the subterminal (St) region.

Type A1 : As above but constriction in the submedian (Sm) region.

Type A2 : As above, however, constriction in the median (m) region.

Type B : Long chromosomes (5.0 - 6.5 mu) with constriction in the subterminal (St) region.

Type B1 : As above, however, constriction at submedian (Sm) region.

Type C : Short chromosomes (3.5 - 5.00 mu) with constriction in the subterminal (St) region.

Type C1 : As above, with constriction at submedian (Sm) region.

Type D : Very short chromosomes (less than 3.5 mu) and constriction at subterminal (St) region.

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Type D1 : As above, with constriction at submedian (Sm) region.

Type D2 : As above with constriction at median (m) region.

Somatic chromosomes of D. concanense, D.saxorum, D. montanum (Kartikiswami), D.montanum a form with narrow leaves (Panhala), D. ursulae, D. ursulae with large bulbs, broad leaves and coriaceous bracts (Kas) and D. maharashtrensis with details are presented in Tables 4 to 11, in plate V, figs. 1-7 respectively and other Karyotypic parameters of Dipcadi species are recorded in Table 12 and Indiographically represented in Plate V figs. 8 A to G.

Meiosis as observed in D. concanense revealed normal behaviour of chromosomes in about 80% PMCS (Plate VI figs. 1-7, 13 and 15). There are six bivalents at diakinesis and metaphase I (Plate VI figs. 2-7, 13 & 15). While abnormalities such as abnormal asociation of bivalents (Plate VI fig. 8), clumping of bivalents (Plate VI fig.9), unequal abnormal orientation (Plate VI figs. 10 & 11), unequal groupings (Plate VI fig. 12) and irregular distribution at anaphase I (Plate VI fig. 14) were noted.

In D. saxorum meiosis was found normal in about 70% PMCS with six bivalents at diakinesis (Plate VII fig.1-3, 7,8,9 and 11). While certain irregularities such as AI with lagards (Plate VII fig.10) and metaphase II with irregular

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orientation were observed (Plate VII fig.12). Metaphase I with different orientation and typical behaviour of single bivalent is seen in plate VII figs. 4-6.

In Dipcadi ursulae (A form with large bulb, broad leaves and coriaceous bracts) normal meiosis was observed in PMCS in a range between 60 to 75%. While some irregularities such as irregular orientation of bivalents at diakinesis was observed (Plate VIII fig.5). At diakinesis stage PMCS showed two nucleoli (Plate VIII fig. 1-4).

D. montanum (narrow leaved form) showed normal meiosis in about 60 to 70% PMCS (Plate VIII figs. 7-9) however, some abnormalities such as MI with clumped bivalents, AI with abnormal segregation (Plate VIII fig.6) were observed.

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TABLE NO.4

SHOWING KARYOMORPHOLOGICAL DETAILS OF D.CONCANENSE.

Chr.No.	Long arm (L)	Short arm (S)	Total length (C)	L/S	L-S	I=100 S/C	
1.	6.07 ± 1.01	1.19 ± 0.34	7.28 ± 1.23	5.10	4.88	16.34	St
2.	5.59 ± 0.87	1.06 ± 0.27	6.66 ± 1.01	5.27	4.53	15.91	St
3.	4.78 ± 1.18	1.13 ± 0.18	5.91 ± 1.28	4.23	3.65	19.78	St
4.	2.08 ± 0.49	0.80 ± 0.17	2.88 ± 0.45	2.6	1.28	27.7	Sm
5.	1.65 ± 0.30	0.84 ± 0.19	2.50 ± 0.37	1.96	0.81	33.6	Sm
6.	1.36 ± 0.27	0.81 ± 0.21	2.18 ± 0.36	1.67	0.55	37.1	Sm
Total length	21.53	5.83	27.21				

TABLE NO. 5

SHOWING KARYOMORPHOLOGICAL DETAILS OF D. SAXORUM

Chr.No.	Long arm (L)	Short arm (S)	Total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	4.48 ± 0.91	1.18 ± 0.49	5.67 ± 0.75	3.79	3.3	20.81	St
2.	3.94 ± 0.79	1.22 ± 0.59	5.17 ± 0.91	3.22	2.72	23.59	St
3.	3.36 ± 0.68	1.18 ± 0.45	4.53 ± 0.81	2.84	2.18	26.04	Sm
4.	2.41 ± 0.46	1.01 ± 0.25	3.42 ± 0.48	2.38	1.4	29.53	Sm
5.	1.87 ± 0.52	0.95 ± 0.27	2.84 ± 0.58	1.96	0.92	33.45	Sm
6.	1.03 ± 0.16	0.68 ± 0.14	1.71 ± 0.27	1.51	0.35	39.76	m
Total length	17.09	6.22	23.29				

TABLE NO.6

SHOWING KARYOMORPHOLOGICAL DETAILS OF D.MAHARASHTRENSIS (A FORM WITH CORIACEOUS BRACTS FROM KAS)

Chr.No.	Long Arm (L)	Short arm (S)	Total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	4.28 ± 0.72	2.58 ± 0.54	6.87 ± 1.20	1.66	1.7	37.55	m
2.	5.17 ± 0.76	1.42 ± 0.26	6.56 ± 0.87	3.64	3.75	21.64	St
3.	4.82 ± 0.70	1.04 ± 0.19	5.87 ± 0.82	4.63	3.78	17.72	St
4.	4.33 ± 0.70	0.96 ± 0.19	5.32 ± 0.68	4.51	3.37	18.05	St
5.	3.55 ± 0.62	0.84 ± 0.19	4.39 ± 0.66	4.23	2.71	19.13	St
6.	3.01 ± 0.52	0.82 ± 0.18	3.85 ± 0.54	3.67	2.69	21.30	St
7.	2.33 ± 0.33	0.73 ± 0.14	3.06 ± 0.39	3.19	1.6	23.86	St
8.	1.72 ± 0.20	0.73 ± 0.16	2.44 ± 0.24	2.36	0.99	29.92	Sm
9.	1.39 ± 0.24	0.68 ± 0.11	2.07 ± 0.26	2.04	0.71	32.85	Sm
10.	1.22 ± 0.20	0.59 ± 0.11	1.81 ± 0.20	2.08	0.63	32.67	Sm
Total length	10.4	32.20	42.24				

TABLE NO.7

SHOWING KARYOMORPHOLOGICAL DETAILS OF D. URSULAE (MAHABLESHWAR-PANCHGANI PLATEAU)

Chr No.	Long arm (L)	Short arm (S)	Total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	3.85 ± 0.72	2.31 ± 0.39	6.16 ± 0.94	1.66	1.54	37.5	Sm
2.	4.65 ± 0.68	1.28 ± 0.25	5.92 ± 0.78	3.69	3.39	21.28	St
3.	4.19 ± 0.71	1.02 ± 0.18	5.23 ± 0.74	4.10	3.17	19.50	St
4.	3.55 ± 0.63	0.94 ± 0.28	4.50 ± 0.63	3.77	2.61	20.88	St
5.	3.02 ± 0.50	0.77 ± 0.14	3.77 ± 0.58	3.92	2.25	20.42	St
6.	2.67 ± 0.47	0.75 ± 0.77	3.43 ± 0.52	3.56	1.92	21.86	St
7.	2.19 ± 0.55	0.76 ± 0.18	2.95 ± 0.54	2.77	1.43	25.76	St
8.	1.57 ± 0.31	0.79 ± 0.18	2.37 ± 0.40	1.98	0.78	33.33	Sm
9.	1.32 ± 0.28	0.68 ± 0.12	2.01 ± 0.31	1.94	0.64	33.83	Sm
10.	1.08 ± 0.22	0.65 ± 0.09	1.7 ± 0.26	1.66	0.43	38.23	m
Total Length	28.09	9.87	38.04				

TABLE NO.8

SHOWING KARYOMORPHOLOGICAL DETAILS OF D.MONTANUM (KARTIKISWAMI)

Chr.No.	Long arm (L)	Short arm (S)	Total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	4.69 ± 0.71	2.76 ± 0.44	7.46 ± 0.79	1.70	1.93	36.99	Sm
2.	5.26 ± 0.49	1.55 ± 0.24	6.80 ± 0.57	3.39	3.71	22.79	St
3.	5.30 ± 0.67	1.05 ± 0.13	6.34 ± 0.65	5.05	4.25	16.56	St
4.	4.40 ± 0.67	1.00 ± 0.17	5.40 ± 0.73	4.4	3.40	18.51	St
5.	3.37 ± 0.52	0.84 ± 0.19	4.61 ± 0.53	4.01	2.53	18.22	St
6.	3.13 ± 0.53	0.77 ± 0.14	3.89 ± 0.49	4.06	2.36	19.79	St
7.	2.43 ± 0.32	0.82± 0.14	3.25 ± 0.32	2.96	1.61	25.23	Sm
8.	1.72 ± 0.44	0.80 ± 0.11	2.54 ± 0.42	2.15	0.92	31.50	Sm
9.	1.29± 0.19	0.71 ± 0.14	1.97 ± 0.23	1.82	0.58	36.04	Sm
10.	1.08 ± 0.13	0.63 ± 0.11	1.72 ± 0.21	1.71	0.45	36.62	Sm
Total Length	32.67	10.93	43.98				

TABLE NO.9

SHOWING KARYOMORPHOLOGICAL DETAILS OF D. URSULAE
(A FORM WITH LARGE BULBS, BROAD LEAVES AND CORIACEOUS BRACTS)

Chr.No.	Long arm (L)	Short arm (S)	Total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	4.93 ± 0.58	2.91 ± 0.46	7.84 ± 0.90	1.69	2.02	37.12	Sm
2.	6.49 ± 1.13	1.55 ± 0.41	8.05 ± 1.32	4.19	4.87	19.26	St
3.	5.70 ± 0.72	1.18 ± 0.29	6.89 ± 0.86	4.83	4.52	17.13	St
4.	4.81 ± 0.90	1.08 ± 0.22	5.88 ± 0.99	4.45	3.73	18.37	St
5.	4.00± 0.70	0.89 ± 0.20	4.91 ± 0.76	4.49	3.11	18.13	St
6.	3.49 ± 0.66	0.79 ± 0.20	4.28 ± 0.65	4.41	2.7	18.46	St
7.	2.51 ± 0.54	0.83 ± 0.17	3.34 ± 0.54	3.02	1.68	24.85	St
8.	1.96 ± 0.40	0.81 ± 0.14	2.78 ± 0.41	2.42	1.15	29.14	Sm
9.	1.49 ± 0.25	0.78 ± 0.13	2.27 ± 0.30	1.91	0.71	34.36	Sm
10.	1.30 ± 0.24	0.66 ± 0.14	1.97 ± 0.32	1.97	0.64	33.50	Sm
Total Length	36.68	11.48	48.21				

TABLE NO.10

SHOWING KARYOMORPHOLOGICAL DETAILS OF D.MONTANUM (A NARROW LEAVED FORM-PANHALA)

Chr.No.	Long arm (L)	Short arm (S)	total length (C)	R=L/S	R=L-S	I=100 S/C	
1.	4.91 ± 1.07	3.03 ± 0.72	8.00 ± 1.07	1.62	1.88	37.88	m
2.	6.15 ± 1.09	1.57 ± 0.40	7.70 ± 1.13	3.92	4.58	20.39	St
3.	5.74 ± 1.10	1.10 ± 0.31	6.84 ± 1.18	5.22	4.64	16.08	St
4.	4.87 ± 1.08	0.90 ± 0.20	5.78 ± 1.13	5.41	3.97	15.57	St
5.	4.02 ± 0.74	0.87 ± 0.14	4.90 ± 0.79	4.62	3.15	17.75	St
6.	3.59 ± 0.72	0.75 ± 0.7	4.39 ± 0.78	4.79	2.84	17.08	St
7.	2.57 ± 0.59	0.73 ± 0.11	3.39 ± 0.59	3.52	1.84	21.53	St
8.	1.88 ± 0.32	0.71 ± 0.14	2.62 ± 0.38	2.65	1.17	27.10	Sm
9.	1.45 ± 0.27	0.68 ± 0.14	2.11 ± 0.34	2.13	0.77	32.23	Sm
10.	1.09 ± 0.2	0.61 ± 0.13	1.72 ± 0.33	1.79	0.48	35.47	Sm
Total length	36.27	10.95	47.45				

C) ANATOMY

(a) Scape Anatomy (Text fig.II, figs 1-3 and Text fig.III figs 1-4).

All the species and forms of Dipcadi growing in Maharashtra have unbranched cylindrical scapes. The length and basal diameter of scape varied in various species of Dipcadi. Similarly the number of flower per scape varied greatly in different species and forms of species. Anatomical characters of scape are depicted in Table 13. No significant differences in anatomical characters of scapes of different species and forms were observed and therefore, general anatomical characters of scape are given below.

The diameter of scape varied in different species and forms. Tangential section of scape is circular in outline. Epidermis is single layered made up of vertically elongated cells. In transection cells are rectangular to oval in outline. The outer surface of the epidermis is covered by cuticle. The continuity of epiclermis is broken by presence of stomata. Below guard cells there is stomatal cavity. Epidermis is followed by hypodermis. Hypodermis is made-up of radially elongated cells packed with chloroplasts forming palisadelike layer. Hypodermis is followed by outer cortex made up of 5 to 8 layers of parenchyma. One to two outer layers are made up of small oval parenchymatous cells

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which contains chloroplasts while inner three to five layers are made up of large parenchymatous cells enclosing intercellular spaces. The cells of these layers may contain few starch grains and chloroplasts or are devoid of them. Outer cortex is followed by sclerenchymatous inner cortex. Inner sclerenchymatous cortex varies in thickness in various species. It is made up of polygonal, thick walled sclerenchymatous cells. Sclerenchymatous cells vary in length in different species. Small vascular bundle are found associated with sclerenchymatous cortex. They are found in outer as well as inner layers of sclerenchymatous cortex. Ground parenchyma is made up of large oval cells without any reserve food. They are loosely arranged enclosing intercellular spaces. Vascular bundles are found scattered in ground parenchyma. They vary in size, shape and number in different species. Each vascular bundle is conjoint, collateral and closed type. Each vascular bundle is surrounded by indistinct sclerenchymatous sheath. Xylem consists of varying number of metaxylem and protoxylem elements. Metaxylems are arranged either in one or two rows and show spiral thickening on their walls.

D. concanense (Text fig.II fig.1) shows 13 to 22 small vascular bundles associated with sclerenchymatous cortex and 9 to 13 large vascular bundle in ground parenchyma.

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The outer cortex is about 117 mu in thickness while sclerenchymatous cortex is about 130 mu in thickness. Average size of large vascular bundles is about 234 x 90 mu. The length of epidermal cell is about 252 mu.

D. saxorum (Text fig.II fig.2) shows 14-23 small vascular bundles associated with sclerenchymatous cortex and 5-12 large vascular bundles in ground parenchyma. Thickness of outer cortex is about 36 mu while of selerenchymatous cortex is 93 mu. The average size of large vascular bundles is about 227 x 193 mu. Broadest vascular bundles are found in the species. The length of epidermal cell is about 285 mu.

D. montanum (Tex fig. III fig.3) consists of 12 to 16 small vascular bundles associated with sclerenchymatous cortex and 7-10 large bundles in central ground parenchyma. The thickness of outer cortex is about 91 mu while that of sclerenchymatous cortex is about 143 mu. Average size of large vascular bundles is about 220 x 93 mu. The length of epidermal cell is about 503 mu.

Dipcadi with narrow leaves (Text fig.III fig.4) has 13-19 small vascular bundles associated with sclerenchymatous sheath and 8 to 10 large bundles in ground parenchyma. The thickness of outer cortex is about 93 mu while that of

...51...

sclerenchymatous cortex is about 135 mu. Average size of large central vascular bundle is about 184 x 57 mu. The length of epidermal cell is about 314 mu.

D. ursulae (Tex fig.III fig.2) has 27-35 small vascular bundles associated with sclerenchymatous cortex and 13-17 large bundles in ground parenchyma. The thickness of outer cortex is about 169 mu. While that of sclerenchymatous cortex is about 218 mu. Average size of large vascular bundles is about 208 x 67 mu. The length of epidermal cell is about 434 mu.

Dipcadi with broad leaves and coriaceous bracts (D. ursulae). (Text fig.III fig.3) consists of 20-30 small vascular bundles associated with sclerenchymatous cortex and 13-17 large vascular bundles in ground parenchyma. The thickness of outer cortex is about 185 mu. While that of inner sclerenchymatous cortex is about 197 mu. Average size of large vascular bundle is about 241 x 90 mu. The length of epidermal cell is about 273 mu.

Dipcadi with coriaceous bracts (D. mahareshtrensis) (Text fig.III Fig.4) consists of 20-34 small vascular bundles associated with sclerenchymatous cortex and 10 to 18 large bundles in ground parenchyma. The average thickness of outer cortex is about 221 mu. While that of sclerenchymatous cortex is 217 x 99 mu. The length of

...52...

epidermal cell is about 100 mu.

Minimum number of small vascular bundles associated with sclerenchymatous cortex was found in D. montanum (13) followed by D. saxorum, D. concanense, D. maharashtrensis and maximum in D. ursulae (32). Similarly maximum number of large bundles was found in D. ursulae (15.5) and minimum in D. montanum and D. saxonum (8.6). Thick outer cortex was found in D. maharastrensis (221 mu) followed by broad leaf form (185 mu) followed by D. ursulae (169 mu) and minimum in D. montanum (91 mu) and D. saxorum (93 mu). The thickness of sclerenchyma varied from 116 mu (D. maharastrensis) to 218 mu (D. ursulae). The size of vascular bundle varied with species. Maximum elongated bundles were found in broad leaf form (241 mu) and minimum in narrow leaved form of D. montanum maximum breadth of vascular bundle was found in D. saxorum while it was minimum in narrow leaved form of D. montanum. The length of epidermal cell varied from 252 mu (D. concanense) to 503 mu (D.montanum).

Above discussed variations are affected by age of plant, climatic and edaphic factors and scape anatomy is of little importance in identification of species.

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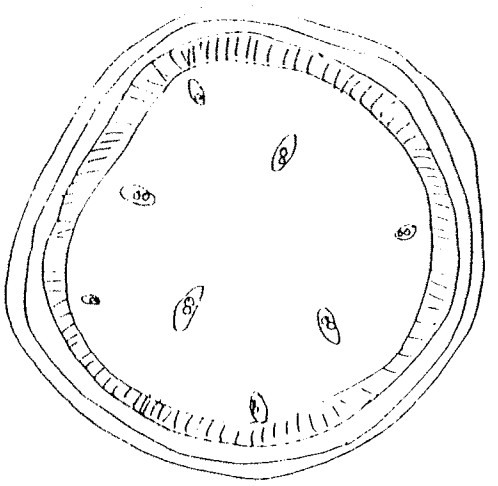
Text Fig. II figs. 1 - 3 : Showing anatomical character of scape of D. concanense, D. saxorum and D. montanum.

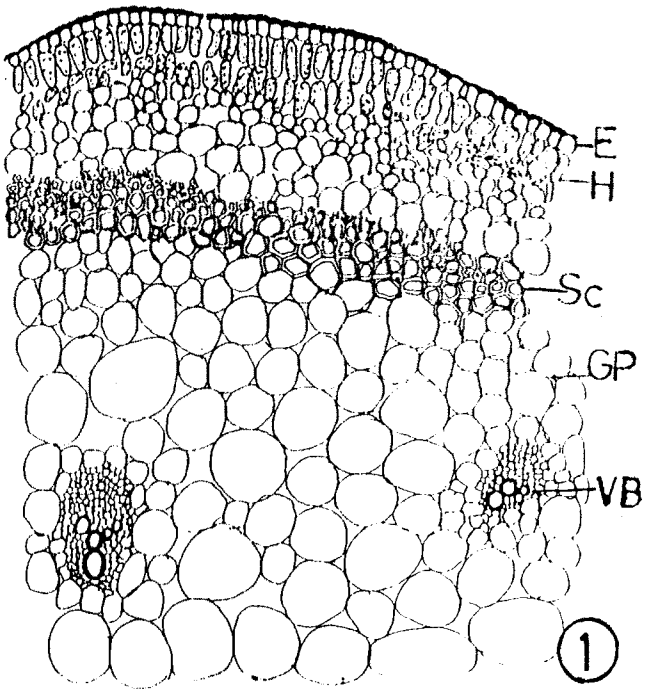
fig. - T.S. of scape of D. concanense x 60 out line x 20

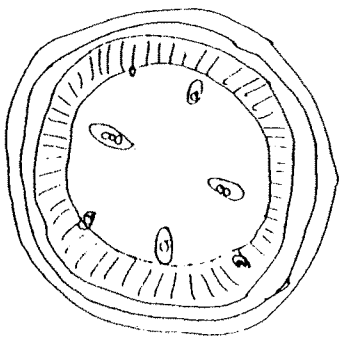
fig. 2 - T.S. of scape of D. saxorum x 60 out line x 20

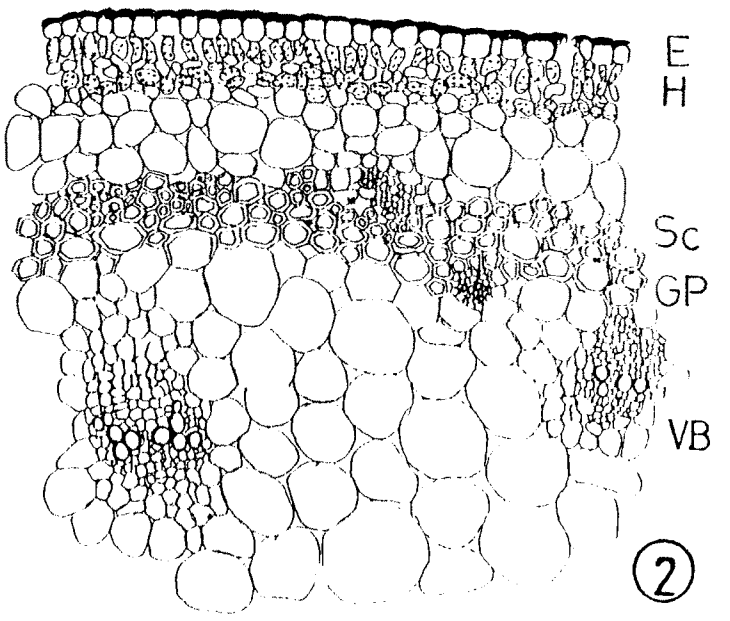
fig. 3 - T.S. of scape of D. montanum x 60 out line x 20

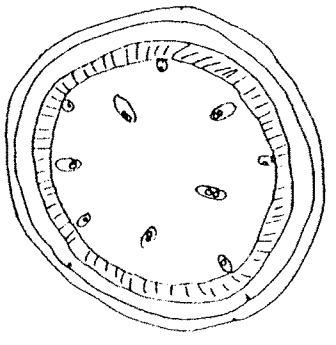
TEXT FIG - II

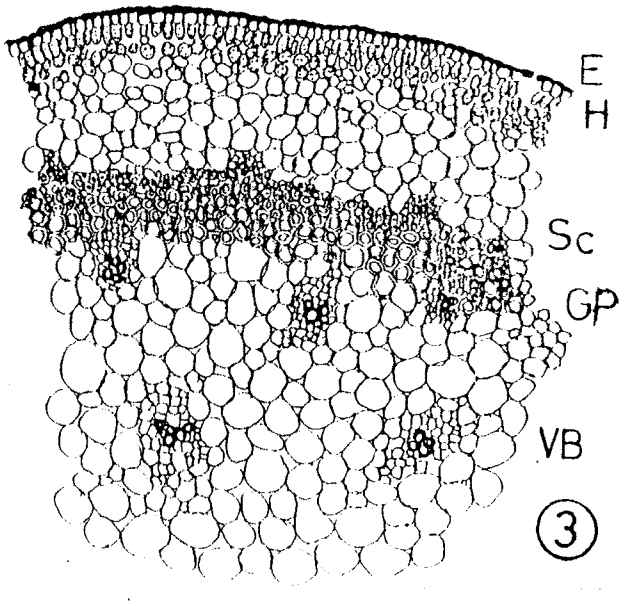












Text Fig. III figs. 1 - 4

Showing anatomical characters of scape of D. montanum (narrow leaved form Panahala), D. ursulae, D. ursulae (a form with large bulb, broad leaves and coriaceous bracts from Kas), D. maharashtrensis (form with coriaceous bracts from Kas and Mahableshwar).

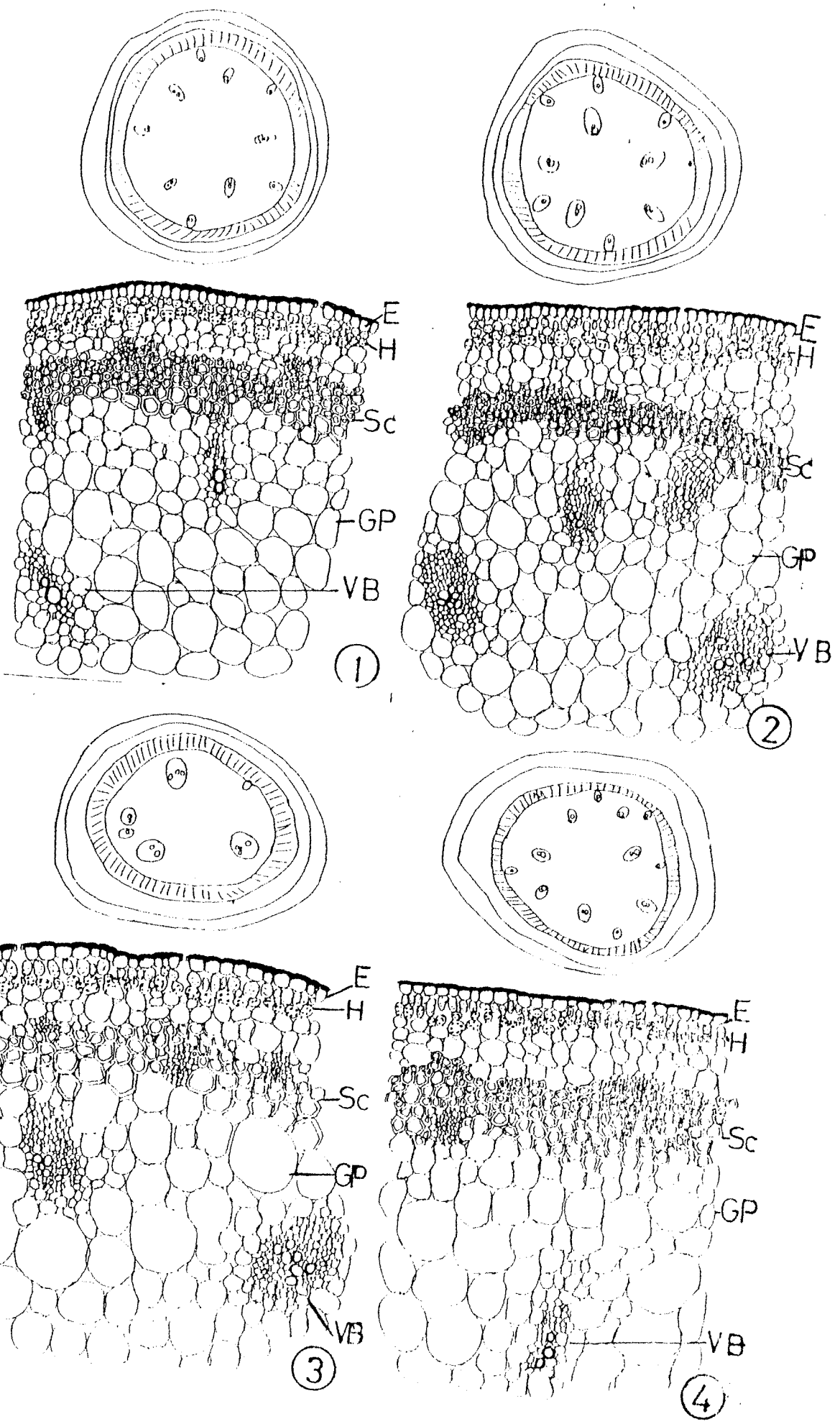
fig. 1 - T.S. of scape of D. montanum (narrow leaved) x 60 out line x 20

fig. 2 - T.S. of scape of D. ursulae x 60 out line x 20

fig. 3 - T.S.of scape of D. ursulae robustform x 60 out line x 20

fig. 4 - T.S. of scape of D. maharashtrensis x 60 out line x 20

TEXT FIG - III



(b) Pedicel Anatomy (Text fig.IV, figs. 1-3 and Text fig.V-figs. 1-4).

Character like pedicel filiform or stout has been used to distinguish some of the Indian species of Dipcadi and therefore, anatomical characters of pedicel were studied. It is difficult to distinguish between stout and filiform pedicel of flower of different species. Similarly it is also difficult to distinguish pedicels of different species on basis of anatomy because all the species show uniform anatomical characters with minor variations. The general anatomical characters of pedicel have been described below.

Tangential section of scape is circular to oval in outline. The epidermis is single layered made up of rectangular to cubical cells. The cells of epidermis are either tangentially or radially elongated. It is covered with very thin cuticle. Continuity of epidermis is broken by presence of stomata. Below stomata there is a distinct stomatal chamber. Epidermis is followed by parenchyma. The outermost 2-3 layers are made up of small cells containing chloroplast while inner 3-4 layers are of large oval parenchymatous cells containing very few or no chloroplasts. Few cells of inner most layer in vicinity of phloem contain few to many starch grains. The cells of inner layer enclose inter cellular spaces. Vascular bundles are arranged in approximately

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two circles. The outer vascular bundles range in number from 9-12 and are smaller in size. Inner vascular bundles are larger in size and range in number from 5 to 6. Vascular bundles are conjoint, collateral and closed type. In the centre of pedicel there is a parenchyma which may or may not contain starch grains.

Studies on pedicel anatomy revealed that the gross anatomical characters remain same in all the species studied. Differences in diameter of scape, size and shape of epidermal cells, extent of chlorenchyma, size and shape of vascular bundles and abundance of starch grains were observed.

D. concanense, D. saxorum, D. ursulae and broad leaf form (D. ursulae) showed radially elongated epidermal cells while D. montanum, form with coriaceous bracts (D. maharastrensis) and form with narrow leaves (D. montanum) showed cubical to tangentially elongated rectangular cells. All the species and forms showed presence of stomata in epidermis.

Outermost 2 to 3 layers of parenchyma below epidermis showed presence of chloroplasts. D. ursulae showed abundant chloroplast in these cells as compared to other species and forms of Dipcadi.

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Starch grains were found usually in Parenchymatous cells associated with phloem. D. concanence showed least number of starch grains. While D. ursulae and broad leaf form (D. ursulae) showed abundant starch grains both in parenchymatous cells associated with phloem and also in the centre of pedicel.

Thus all these differences are of little taxonomic value. No any constant character is observed to distinguish stout and filiform pedicel. Moreover the diameter of scape varies with climatic and edaphic factors. Therefore pedicel anatomy is of very little or no importance in identification of species.

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Text Fig. IV figs. 1 - 3

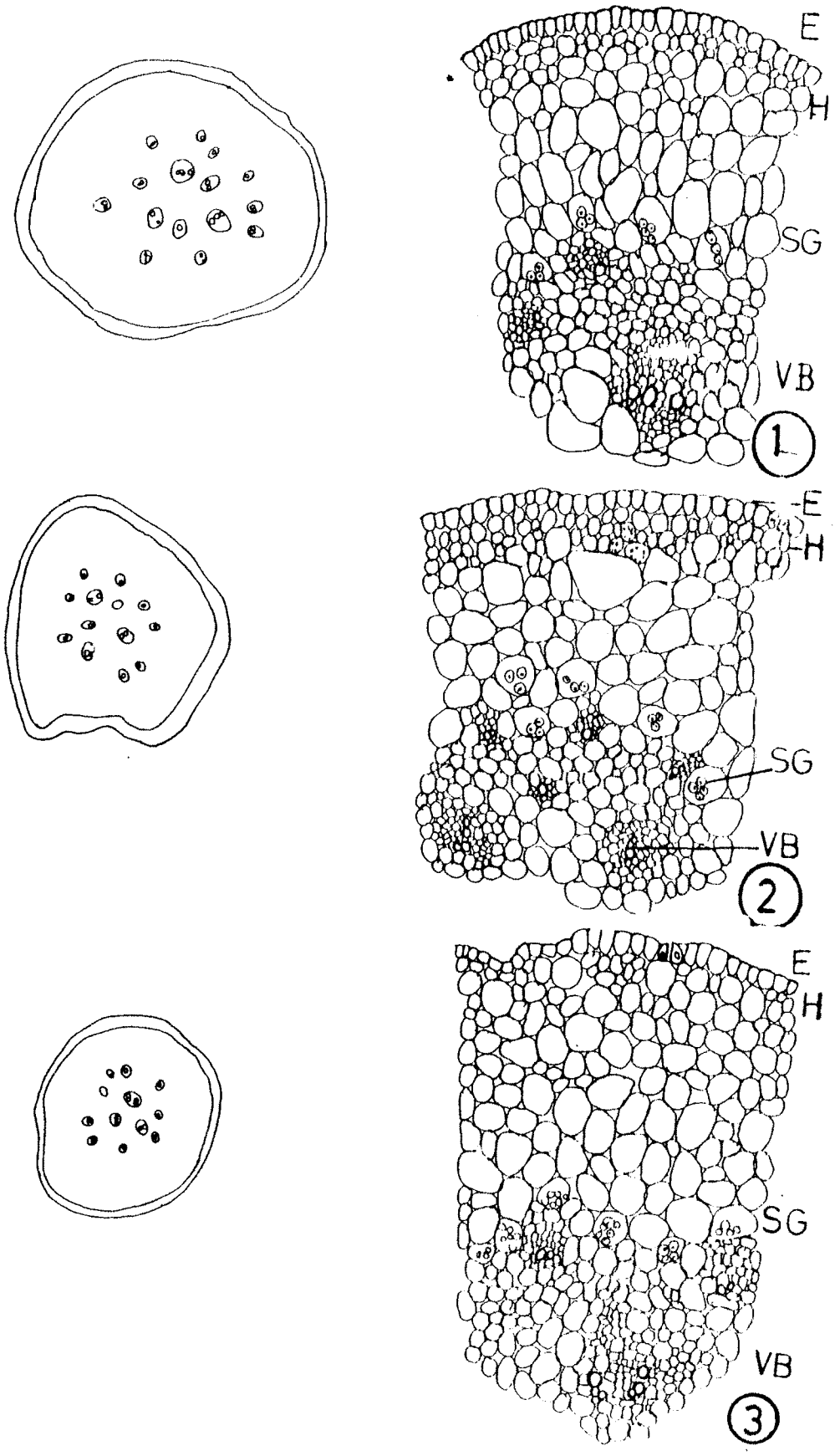
Showing anatomical characters of pedicel of D. concanense, D. saxorum and D. montanum.

Fig. 1 - T.S. of pedicel of D. concanense x 115 out line x 20

Fig. 2 - T.S. of pedicel of D. saxorum x 115 out line x 20

Fig. 3 - T.S. of pedicel of D. montanum x 115 out line x 20

TEXT FIG - IV



Text Fig V figs. 1 - 4

Showing anatomical characters of pedicel of D. montanum (narrow leaves form from Panahala), D. ursulae, D. ursulae (a form with large bulb, broad leaves and coriaceous bracts from Kas), D. maharashtrensis (form with coriaceous bracts from Kas and Mahableshwar)

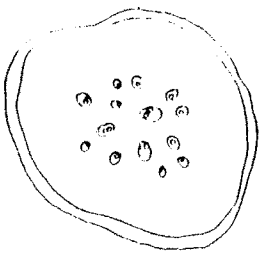
Fig. 1 - T.S. of pedicel of D. montanum (narrow leaved) x 115 out line x 20

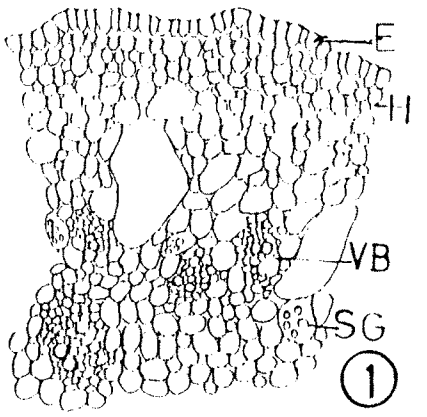
Fig. 2 - T.S. of pedicel of D. ursulae x 115 out line x 20

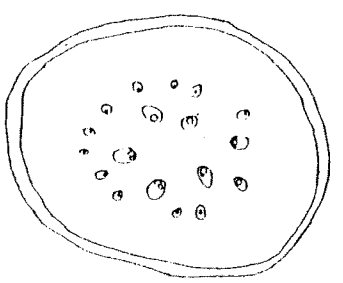
Fig. 3 - T.S. of pedicel of D. ursulae (robust form) x115 out line x 20

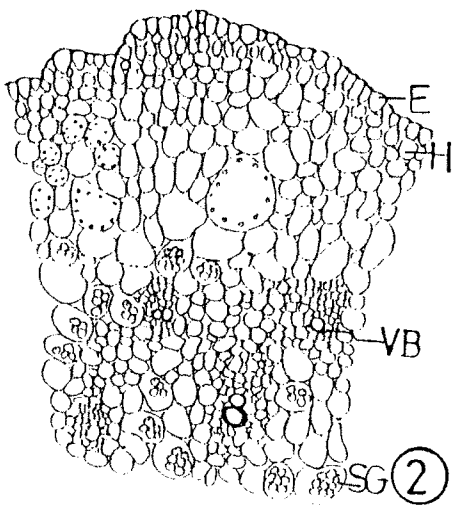
Fig. 4 - T.S. of pedicel of D. maharashtrensis (coriaceous bracts) x 115 out line x 20

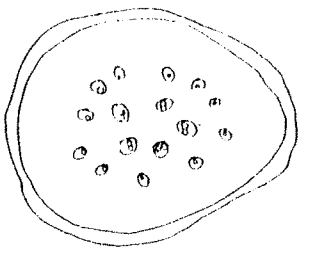
TEXT FIG – V.

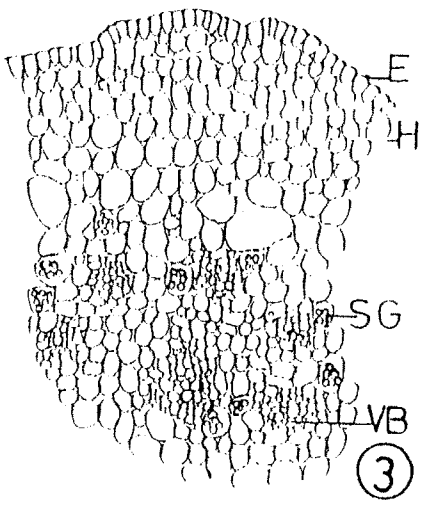


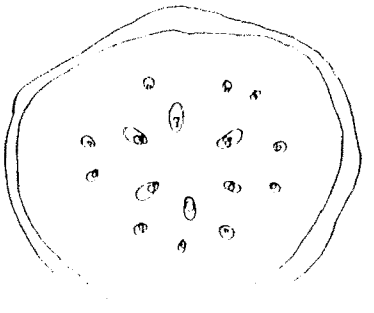


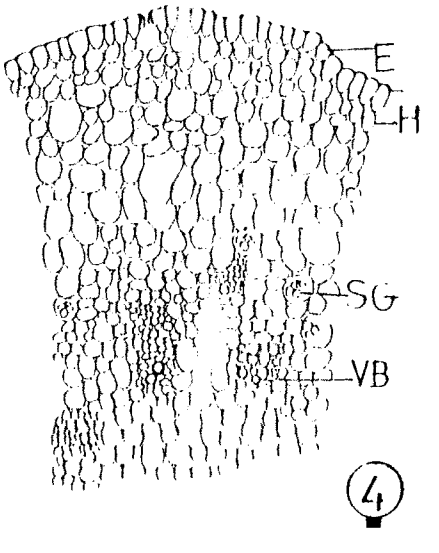












C) Leaf anatomy - (Text fig. VI figs.1-7, Plate IX fig.3)

Some of the species of Dipcadi have been distinguished on the basis of leaf lengthand leaf breadth, however size of leaf varies in same species to considerable extent under different climatic, edaphic and precipitation condition. Gross anatomical characters remain same in different species of Dipcadi growing in Maharashtra.There were no significant variation in anatomical characters except thickness of leaf, number of vascular bundles per leaf, and amounts of different tissues. Moreover these characters vary with the portion of leaf. Leaves are thick at base and show gradual reduction in thickness towards apex. Therefore, general anatomical features of leaf of Dipcadi are described below and some significant variations are shown in Table - 13.

The leaves are isobilateral and amphistomatic. The tangential section of leaf is usually a concave convex structure. Both upper and lower epidermis is single layered made up of cubical cells. The continuity of epidermis is broken by presence of stomata in both the epidermises. The epidermis is covered externally by cuticle. Epidermis on both the sides is followed by single layered palisade. The cells of palisade are vertically elongated and rectangular in shape packed with chloroplasts. Distinct stomatal

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chamber in palisade layer is found below each stoma. Palisade is followed by 1-3 layers of small oval chlorenchymatous cells on either side of leaf. The central portion of leaf is made-up of large parenchymatous cells with intercellular spaces. Few cells in vicinity of phloem may or may not contain starch grains. Vascular bundles are arranged in row in central water storage tissue. Smaller vascular bundles alternate with large vascular bundles. Each vascular bundle consists of 2-4 metaxylem, protoxylem and phloem pointing towards lower epidermis. Some times cells of water storage tissue were found to be broken forming air-chambers.

Different species showed some anatomical differences with respect to presence or absence of raphides, thickness of leaf, number of vascular bundles per leaf and presence or absence of air chambers. They are of secondary value in identification of species as these characters vary with environmental factors and portion of leaf.

In D. concanense (Text fig. VI fig.1) the transection of leaf is concave convex structure. Number of vascular traces ranges from 9-14. The central portion of leaf passes 2-3 air chambers in between vascular bundles. Few starch grains are found in parenchymatous cells in vicinity of phloem. Raphids were found to be present in

...58...

few cells. The leaf margin in T.S. is acute in shape.

In D.saxorum (Text fig. VI fig. 2) the leaves are more or less flat. Number of vascular traces range from 12-15 in number. The central portion of leaf encloses air spaces between vascular bundles. Cells containing few starch grains are found associated with phloem. Regular distribution of raphide cells was observed in lower side of leaf. Leaf margin in T.S. is acute in shape.

D.montanum (Text fig. VI fig.3), D. montanum (narrow leaved form) (Text fig.VI fig.4), D. maharashtrensis (form with coriaceous bracts) (Text fig VI fig. 7) showed similar anatomical characters. Transection of leaf in narrow leaved form (D. montanum) showed ridges and furrows. Ridges corrospond to main vascular traces. Number of vascular traces range from 15-20.Air chambers are found to be present between twc vascular bundle except in lateral portion of leaf. Starch grains and raphid cells were not observed in leaf tissue. The leaf margin is acute in shape.

D. ursulae (Text fig. VI fig.5) and broad leaf form (Text fig.VI fig.6) showed longest and brodest leaves. Transection of leaf showed ridges and furrows corrosponding to vascular bundles and air chambers respectively. Number of vascular bundles varied from 30 to 34. Starch grains and

raphids were not observed in the leaf tissues. The leaf margin in this species is distinct and acuminate in shape.

From above account it is clear that there are no significant differences in anatomy of leaf except leaf breadth, thickness, number of vascular bundles and leaf margin which are of little taxonomic value.

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Text Fig. VI figs. 1 - 7

Showing anatomical characters of leaf of various species of Dipcadi from Maharashtra.

Fig. 1 - T.S. of leaf of D. concanense x 60

Fig. 2 - T.S. of leaf of D. saxorum x 60

Fig. 3 - T.S. of leaf of D. montanum x 60

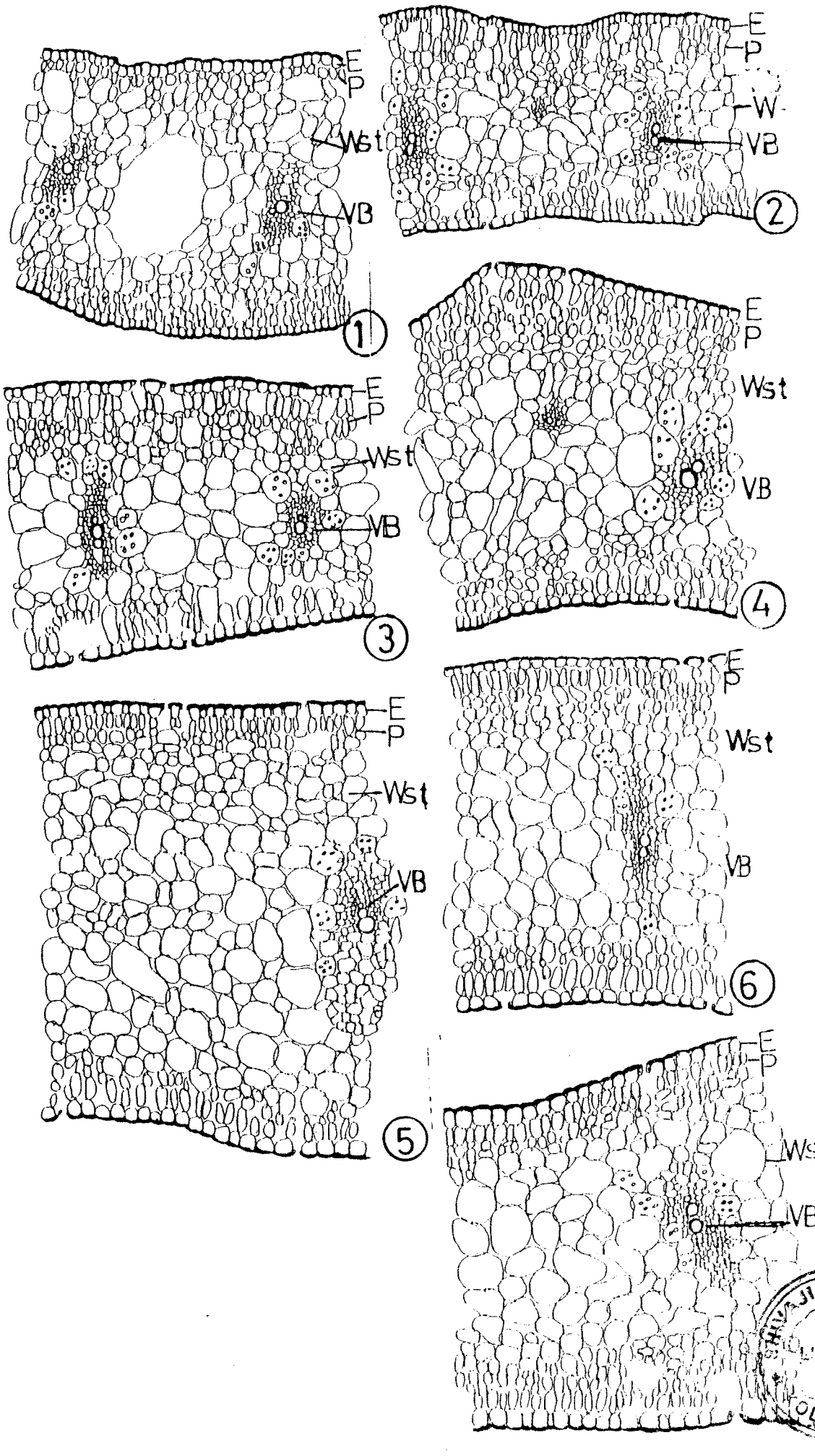
Fig. 4 - T.S. of leaf of D. montanum (narrow leaved) x 60

Fig. 5 - T.S. of leaf of D. ursulae x 60

Fig. 6 - T.S. of leaf of D. ursulae (robust form) x 60

Fig. 7 - T.S. of leaf of D. maharashtrensis (coriaceous bracts) x 60

TEXT FIG - VI



d) Cuticle (Text fig. VII fig. 1-7 plate IX fig.4)

Comparative account of cuticular characters of Dipcadi species and their forms is given in table 14 and shown in Text fig VII, photoplate IV fig.4.The general characters of leaf epidermis of both upper and lower surfaces remain same and therefore general characters of cuticle are given below.

All the species studied have amphistomatic leaves. The leaf epidermal cells of both abaxial and adaxial surfaces are narrow, elongated and lie parallel to leaf axis. They show uniform structural pattern. The size of epidermal cells, stomatal index, stomatal density and stomatal size varied in different species of Dipcadi, how ever there were no significant differences.

Stomatal index of upper epidermis varied from 25 to 38 and it was minimum in form with coriaceous bracts (D. maharashtrensis) and maximum in D. ursulae. Similarly stomatal index on lower epidermis was also found minimum in form with coriaceous bracts viz. 27.8 and maximum in D. saxorum viz. 49.7

Stomatal density was found to be higher on lower epidermis of all Dipcadi species. It ranged from 46 to 130 mm^{-2}. It was found to be minimum inform with coriaceous

...61...

bracts (D. maharashtrensis) and maximum in Dipcadi ursulae and broad leaf form. Stomatal density on upper epidermis varied from 39.4 (D. maharashtrensis) to 78 mm^{-2}(D.ursulae).

There was no significant difference in stomatal size. It ranged from 38.5 x 32.1 (D. concanense) to 60.3 x 49.6 in narrow leved form of D. montanum. Similarly there was insignificant difference between stomatal size of upper and lower surface of each species.

The average epidermal cell length of upper epidermis varied from 361 mu (D. montanum) to 459 mu (D. saxorum) . The average epidermal cell length of lower epidermis varied from 372 mu(narrow leaved form of D. montanum) to 452 mu (D. ursulae). There was no significant difference in breadth of both upper and lower epidermal cells which varied from 41 to 55 mu.

From cuticular studies it becomes clear that there is no single cuticular character of diagnostic value. Similarly no uniform pattern in cuticular character is found in Dipcadi species which could be used to identify species. Therefore, cuticular characters are of little value in taxonomy of species.

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Text Fig. VII figs. 1 - 7

Showing cuticular and stomatal characters of various species of Dipcadi from Maharashtra.

Fig. 1 - Cuticle of D. concanense x 80

Fig. 2 - Cuticle of D. saxorum x 80

Fig. 3 - Cuticle of D. montanum x 80

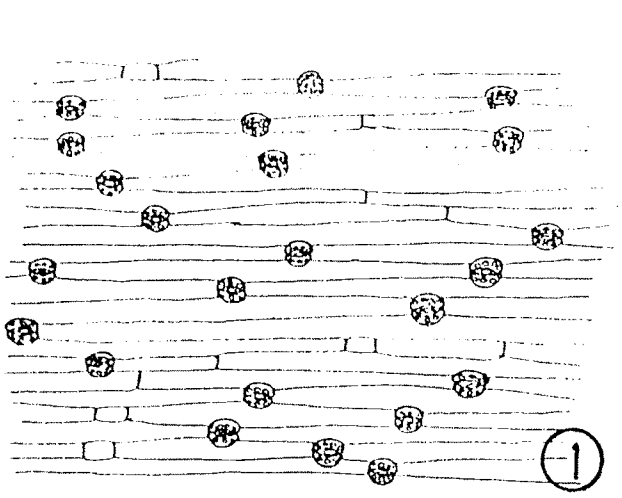
Fig. 4 - Cuticle of D. montanum (narrow leaved) x 80

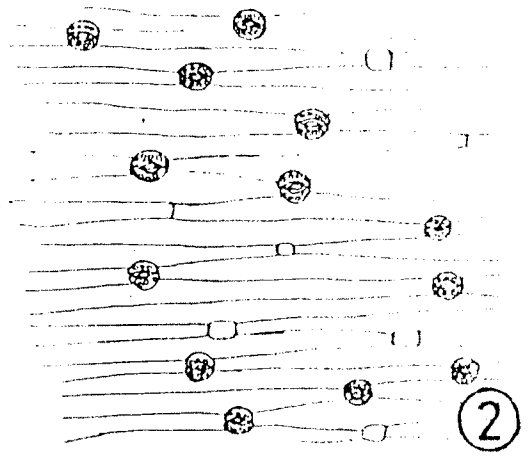
Fig. 5 - Cuticle of D. ursulae x 80

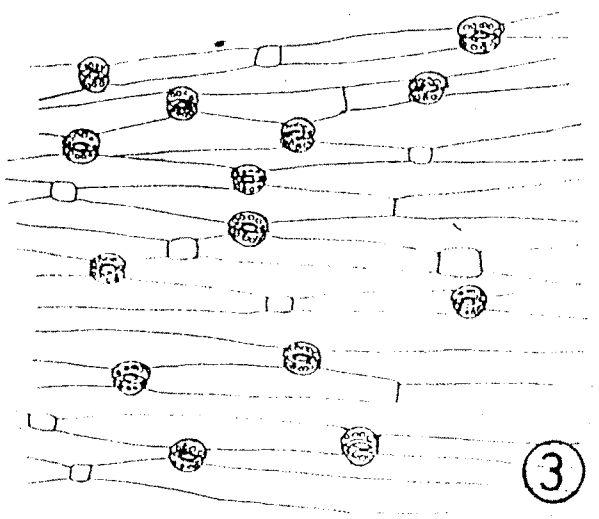
Fig. 6 - Cuticle of D. ursulae (robust form) x 80

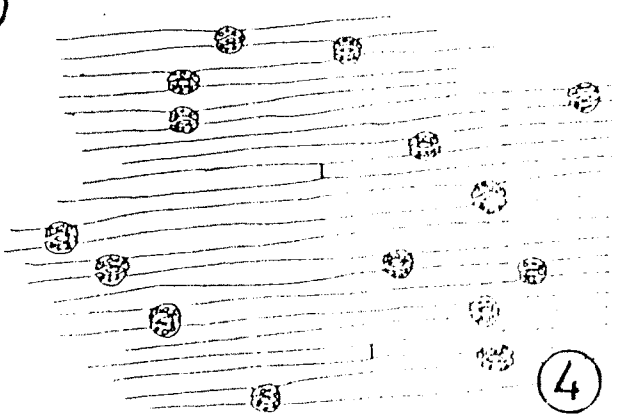
Fig. 7 - Cuticle of D. maharashtrensis (coriaceous bracts) x80

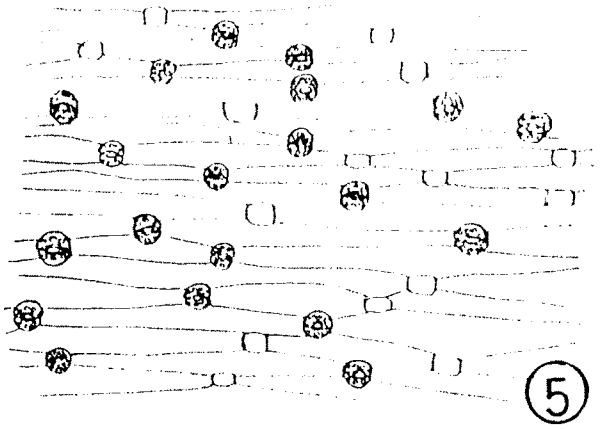
TEXT FIG - VII

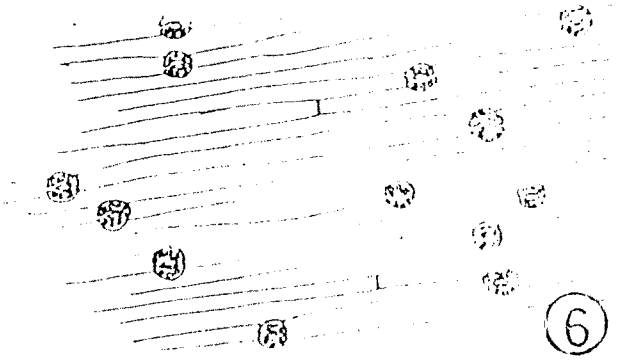


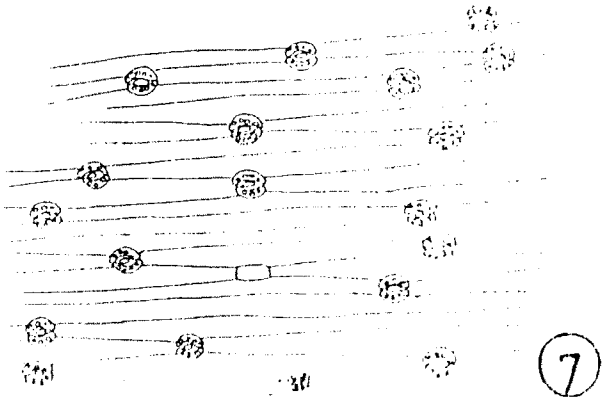












FLORAL ANATOMY :

Floral anatomy of all the species growing in Maharashtra have been studied. The vascular anatomy of flower remains similar in all the species investigated except minor variations in number of vascular bundles per perianth lobe due to splitting of lateral bundles. Therefore floral anatomy of only one species have been described in detail and variations in other species are noted below.

D. concanense (Text figs. VIII fig. 1 to 21).

Pedicel of flower usually consists of 6 main vascular bundles arranged in two rings, each with three bundles (Text fig. VIII fig. 1). The central bundles are large. These main bundles are surrounded by 6-9 small vascular bundles (Text fig. VIII figs. 1-3). Thus there are three rings of vascular bundles, central large,middle small and outer minute bundles. The parenchymatous cells in vicinity of phloem of outer bundles contain starch grains.

All the vascular bundles in pedicel form a plexus of vascular tissue immediately below thalamus. From this vascular plexus 6 main traces are given out to perianth whorl and stamens whorl (Text fig.VIII fig. 4-6). The

...63...

vascular trace corrosponding to small outer vascular bundle of pedicel form vascular system of inner perianth and its stamens while the vascular bundles corrosponding to central large vascular bundles form vasculature of outer perianth and its stamen (Text figs 7-14). Out of 6 traces, each bundle branches into three traces (Text fig. VIII fig. 4-6). Out of these three traces, the middle bundle divides vertically forming two bundle, the inner one forming a single trace going to stamen opposite to the perianth lobe and the outer sister bundle forming median bundle of the perianth lobe (Text fig. VIII figs. 6-16). At the level of ovules when septal nectaries start appering, the lateral bundles of inner whorl of perianth starts dividing (Text fig. VIII fig. 10). Each lateral bundle of inner perianth lobe divides into two (Text fig. VIII fig. 9-11). At about same time lateral bundles of outer perianth lobe also start dividing. At distal part of ovary all the lateral bundles of both inner and outer perianth lobes divide into two. Thus in all 36 vascular bundles are formed out of which 6 go to 6 stamens (Text VIII fig.13). Some of the lateral bundles of both inner and outer perianth lobe divide again (Text fig.VIII fig.14). Finally the outer perianth lobe has 8-11 vascular bundles while the inner perianth lobe is usually 7 nerved (Text fig. VIII fig. 15,16,17). When perianth lobes

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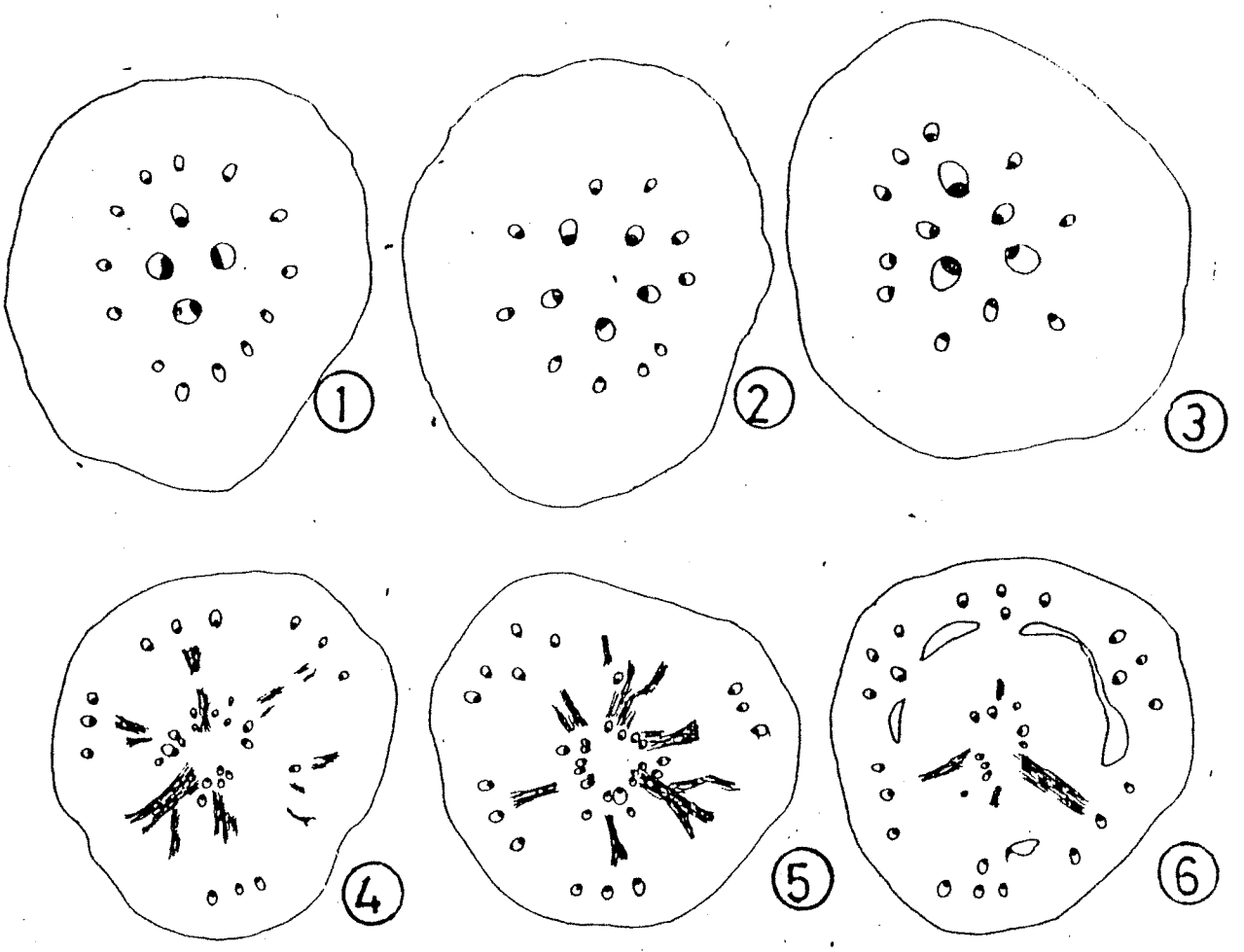
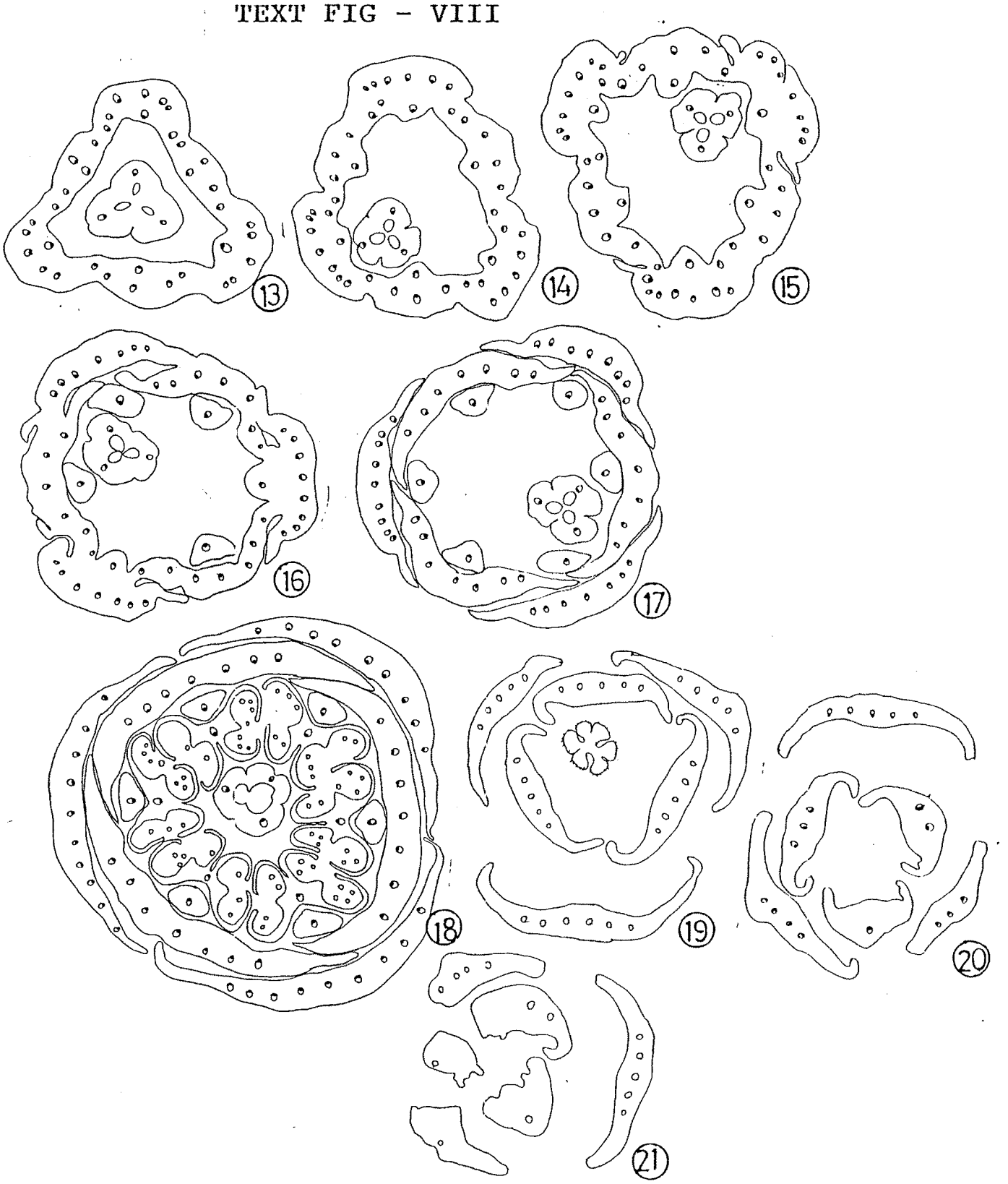
Text Fig. VIII figs. 1 - 21

Showing floral anatomy of *D. concanense* x 20

TEXT FIG - VIII



TEXT FIG - VIII



separate, at about same time the filament bundle inner to median bundle of respective perianth lobe posses into filament gets,separated from perianth lobes (Text fig. VIII figs. 15,16,17). At distal end of flower the lateral bundles of each perianth lobe gradually disappear and finally only one bundle reaches to the apex of perianth lobe (Text fig.VIII fig. 18-21).

When perianth separates from gynoecium, the stipe of ovary just above thalamus consists of 6 vascular bundles. There are three large and three small vascular bundles arranged in approximately single ring (Text fig.VIII fig. 7 and 8). Three large bundles travel outwords and form dorsal bundles of three carpels while smaller bundle travel inwards (Text fig. VIII fig.9).

The inner three small vascular bundles bifurcate and form 6 placental bundles of three carpels (Text figs VIII figs.9-11). Similarly there are 2 minute vascular bundles on either side of nectary (Text fig. VIII figs. 9-11).At distal part of ovary the placental bundles disappear but the dorsal three bundles travel upto base of stigma (Text fig.VIII fig.12). Finally the stigma becomes six lobed with papillate outgrowths (Text fig.VIII fig.19).

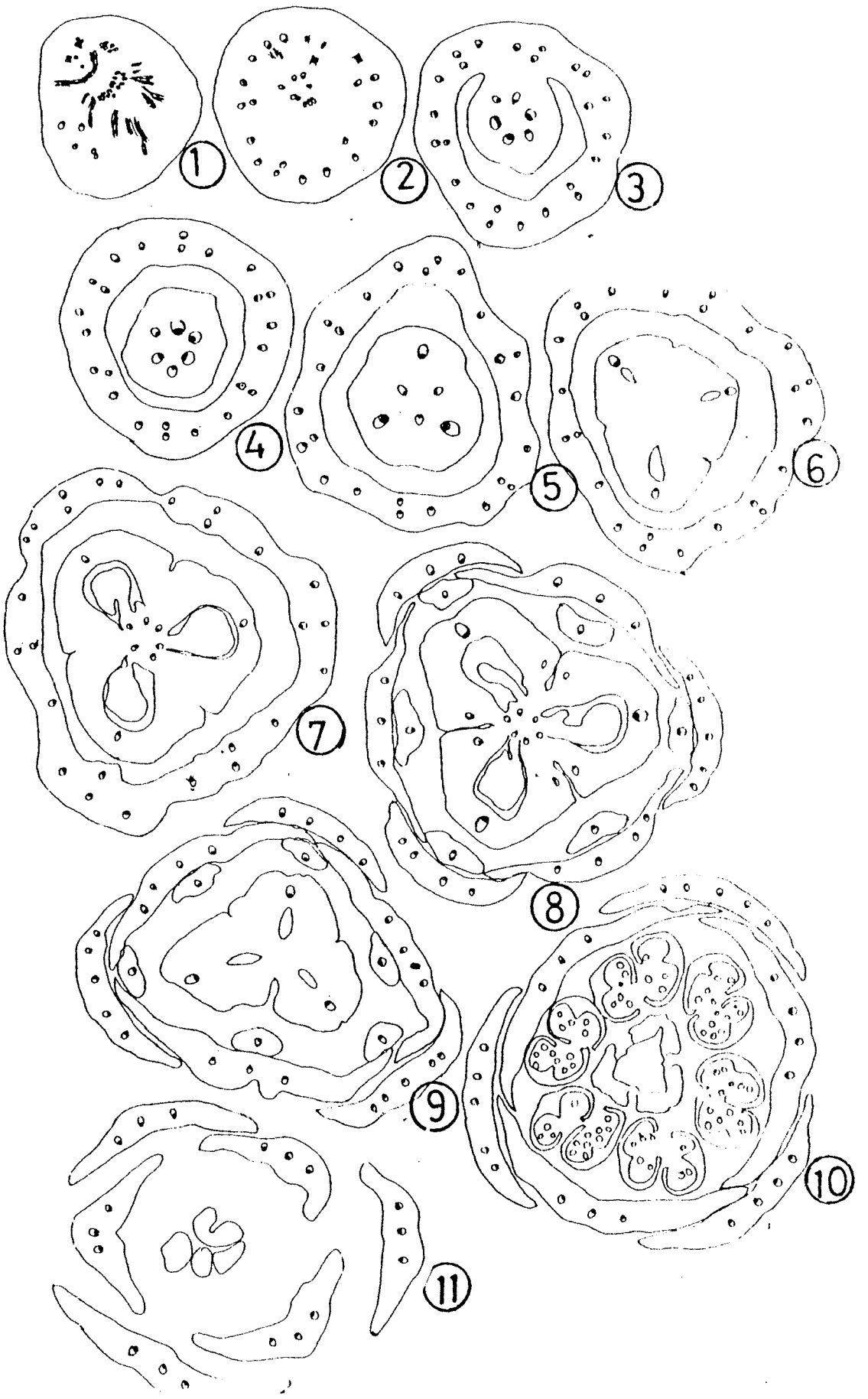
In D. saxorum (Text fig. IX fig. 1 to 11) the traces to perianth lobes are few. The outer perianth has usually

...65...

Text Fig. IX figs. 1 - 11

Showing floral anatomy of D. saxorum x 20

TEXT FIG - IX



5 bundles and the inner perianth has only 3 vascular traces. The course of vasculature is exactly similar to D.concanense.

In D. montanum (Txt fig X figs 1 to 12) the pedicel has 3 large central bundles and 8-9 peripheral small bundles (Text fig. X fig.1). The vascular tissue just below thalamus form a plexus from which 6 main traces are given out (Text fig. X figs. 2 and 3). Each trace divides into 3 (Text fig.X fig 2 and 3) and median bundle divides vertically forming outer bundle going to perianth and single inner bundle going to stamen. Lateral vascular bundle of outer as well as inner perianth divide and form 5 vascular bundles in each perianth lobe (Text figs. X fig. 4-7). The outer perianth lobe becomes 7-8 traced and inner usually remain 5 traced (Text fig X fig.9).

At higher level the lateral bundles may or may not branch (Text fig. X fig.10). The lateral traces in both outer and inner perianth lobe disappear and finally only one median bundle reaches to apex of perianth lobe (Text fig X fig.12).

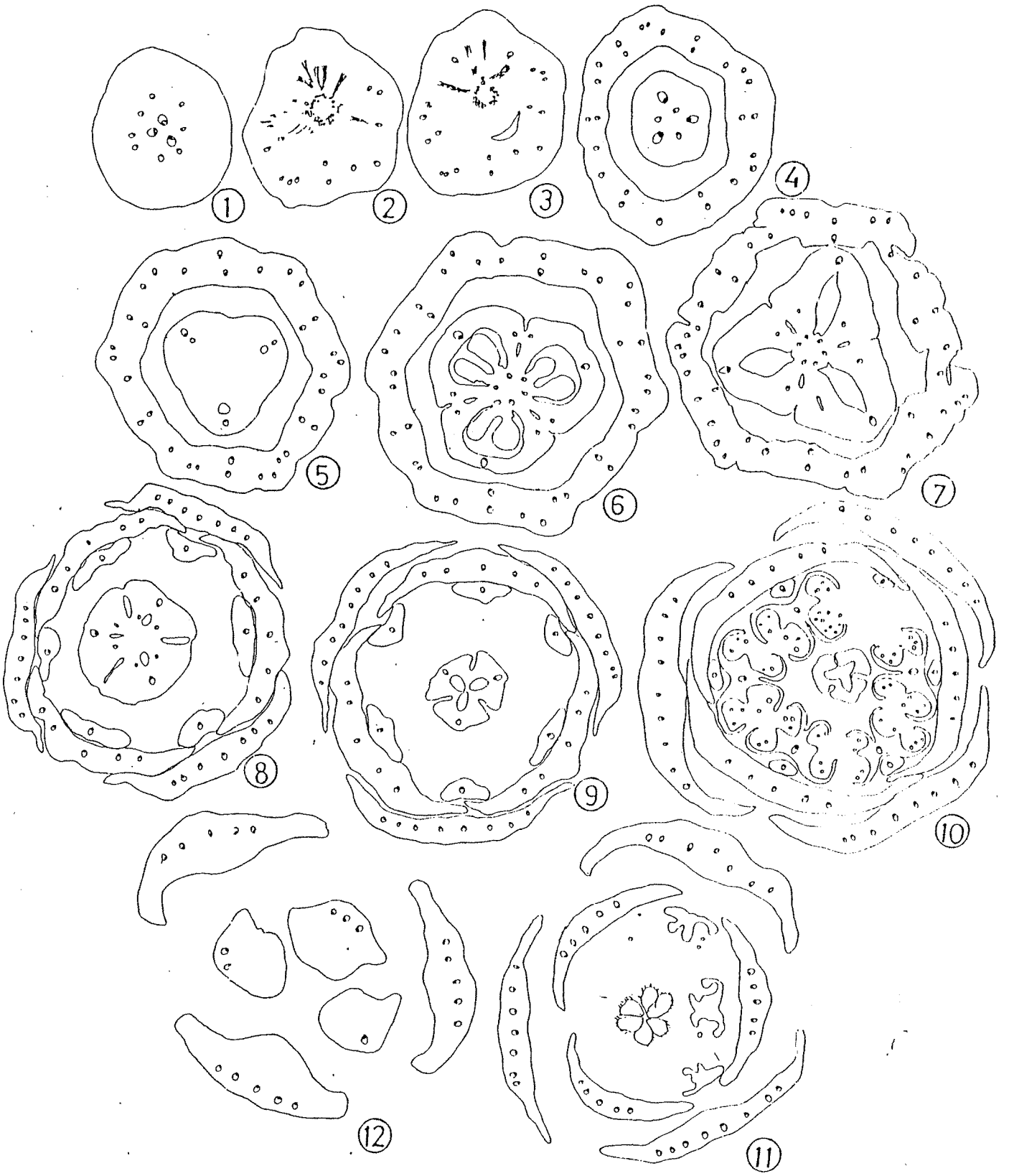
When perianth separates from gynoecium the stipe of ovary shows a ring of 6 vascular bundles. Three large bundles travel to periphery and form dorsal bundles of three carpel one for each. The inner 3 small bundles

...66...

Text Fig. X figs. 1 - 12

Showing floral anatomy of D. montanum x 20

TEXT FIG - X

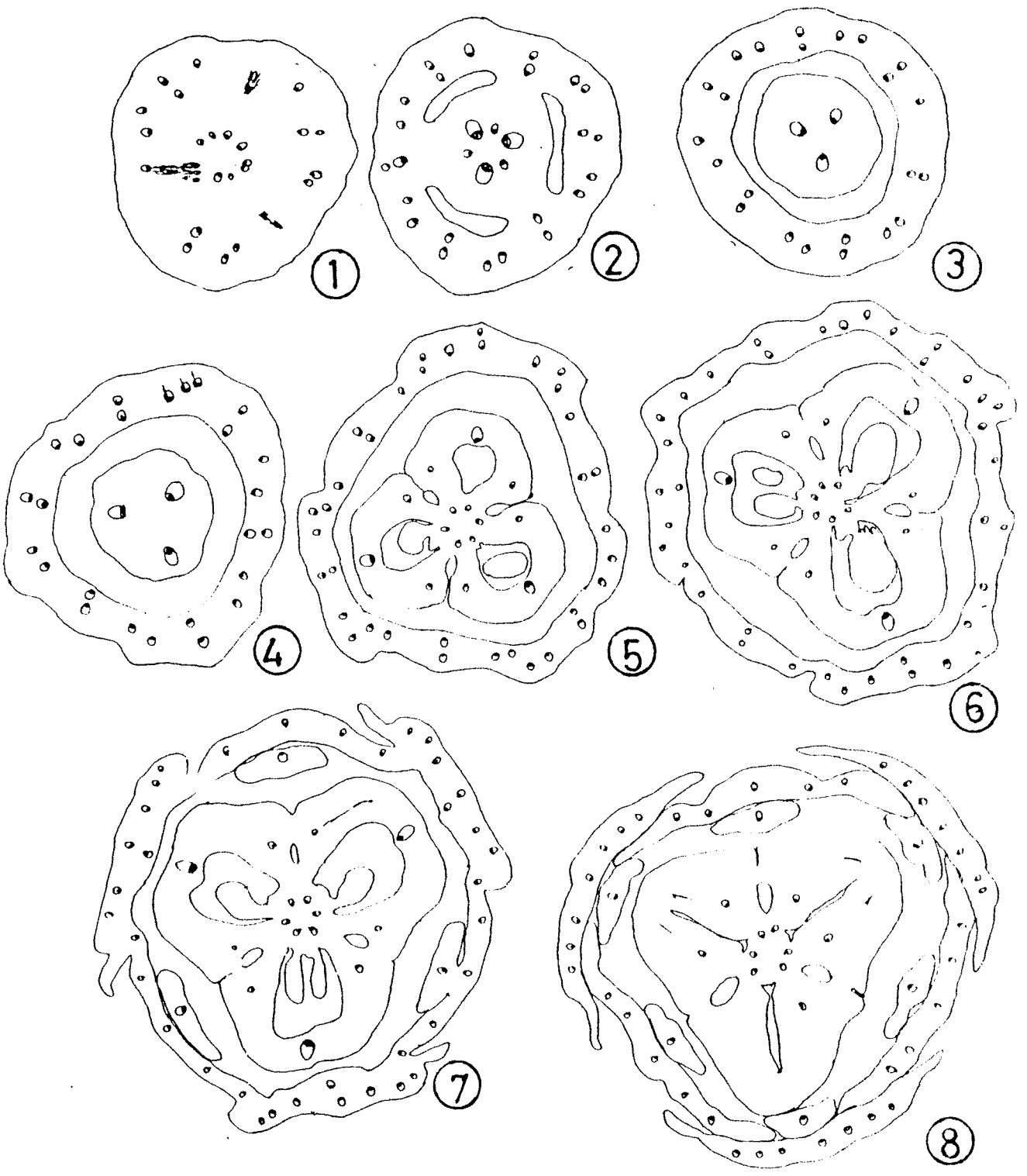


Text Fig. XI figs. 1 - 8

Showing floral anatomy of narrow leaved form of

D. montanum x 20

TEXT FIG – XI



bifurcate and form placental bundles. Very minute two bundles for each carpel on either side of nectary are seen (Text fig.X fig.5). When perianth lobes and filaments separate, the placental bundles and bundles lateral to nectary disappear (Text fig.X fig.8). The three dorsal bundles continue upto base of stigma (Text fig X, fig.9). Finally the stigma becomes papillate and six lobed.

Narrowed leaved form of D. montanum has essentially similar flower vasculature as that of typical D.montanum (Text fig. XI, fig. 1-8). The outer perianth lobe has 6-8 but usually 7 vascular traces and inner perianth lobe is 5-6 but usually 5 nerved.

D. ursulae (Text fig. XII figs 1 to 8) and broad leaf form (Text fig. XIII figs. 1-10) has similar floral anatomy as other species of Dipcadi. The pedicel has 3+3+9 vascular bundles in 3 rings. D. ursulae has 9-13 nerves in outer perianth lobe and inner perianth is usually 7 nerved. In broad leaf form the outer perianth lobe is 7-9 nerved and inner is usually 7 nerved.

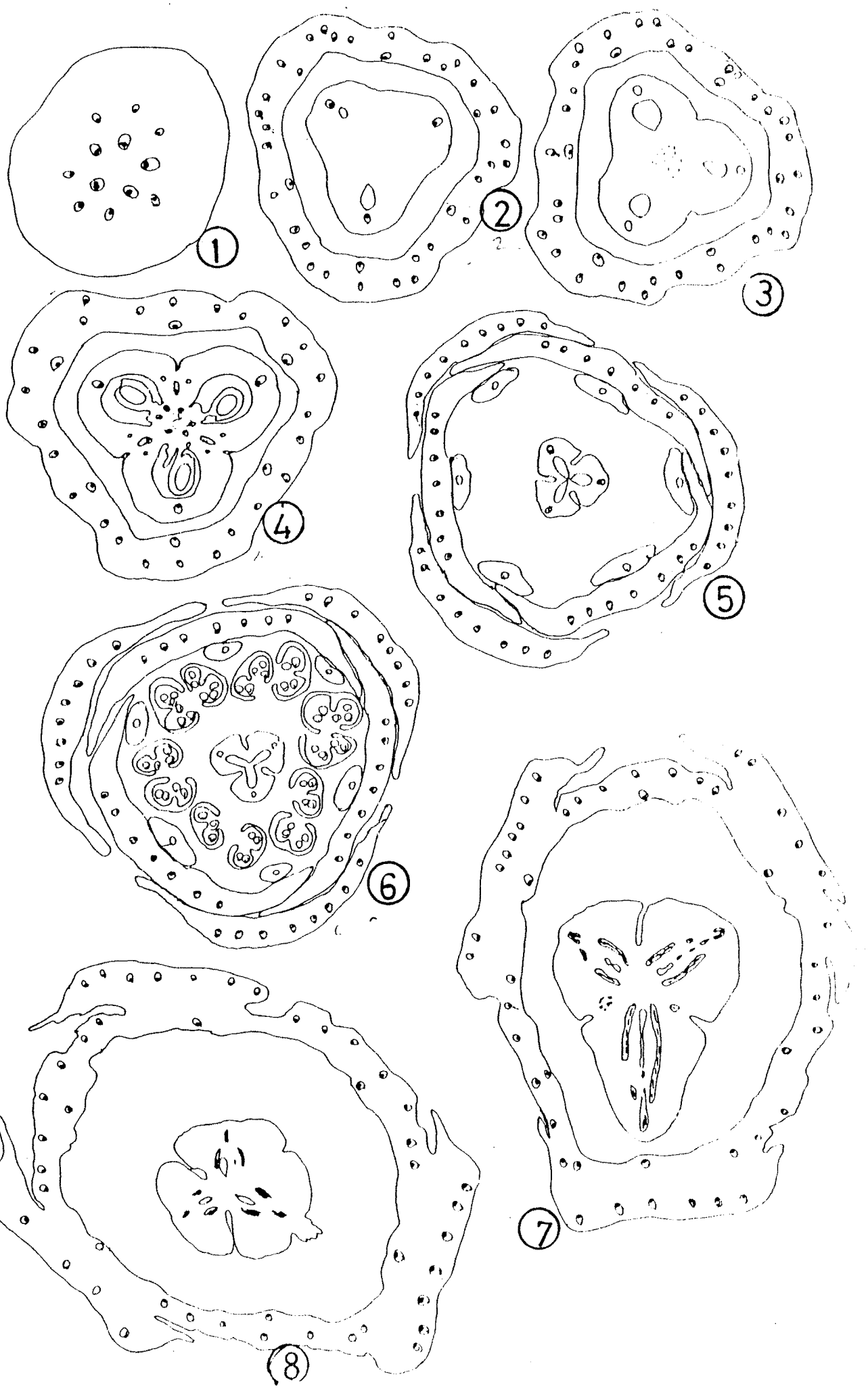
Form with coriaceous bracts (D.maharashtrensis) (Text fig. XIV figs. 1-8) shows similar floral anatomy as D. montanum. The pedicel has 3+3+9 vascular bundles in 3 rings. The outer perianth is usually 7 nerved while inner

...67...

Text Fig. XII figs. 1 - 8

Showing floral anatomy of D. ursulae x 20

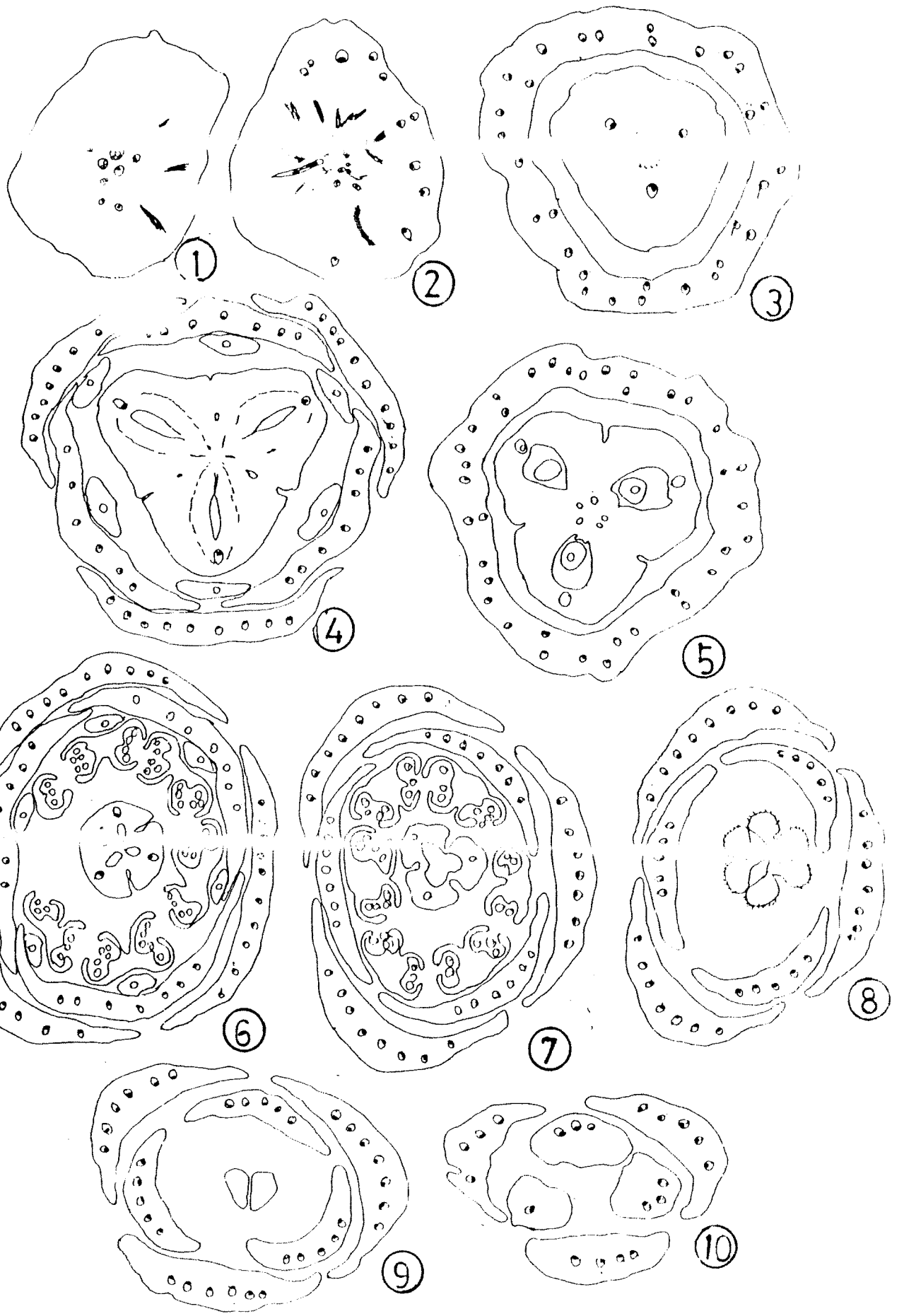
TEXT FIG - XII



Text Fig. XIII figs. 1 - 10

Showing floral anatomy of form with large bulb, broad leaves and coriaceous bracts (*D. ursulae*) x 20

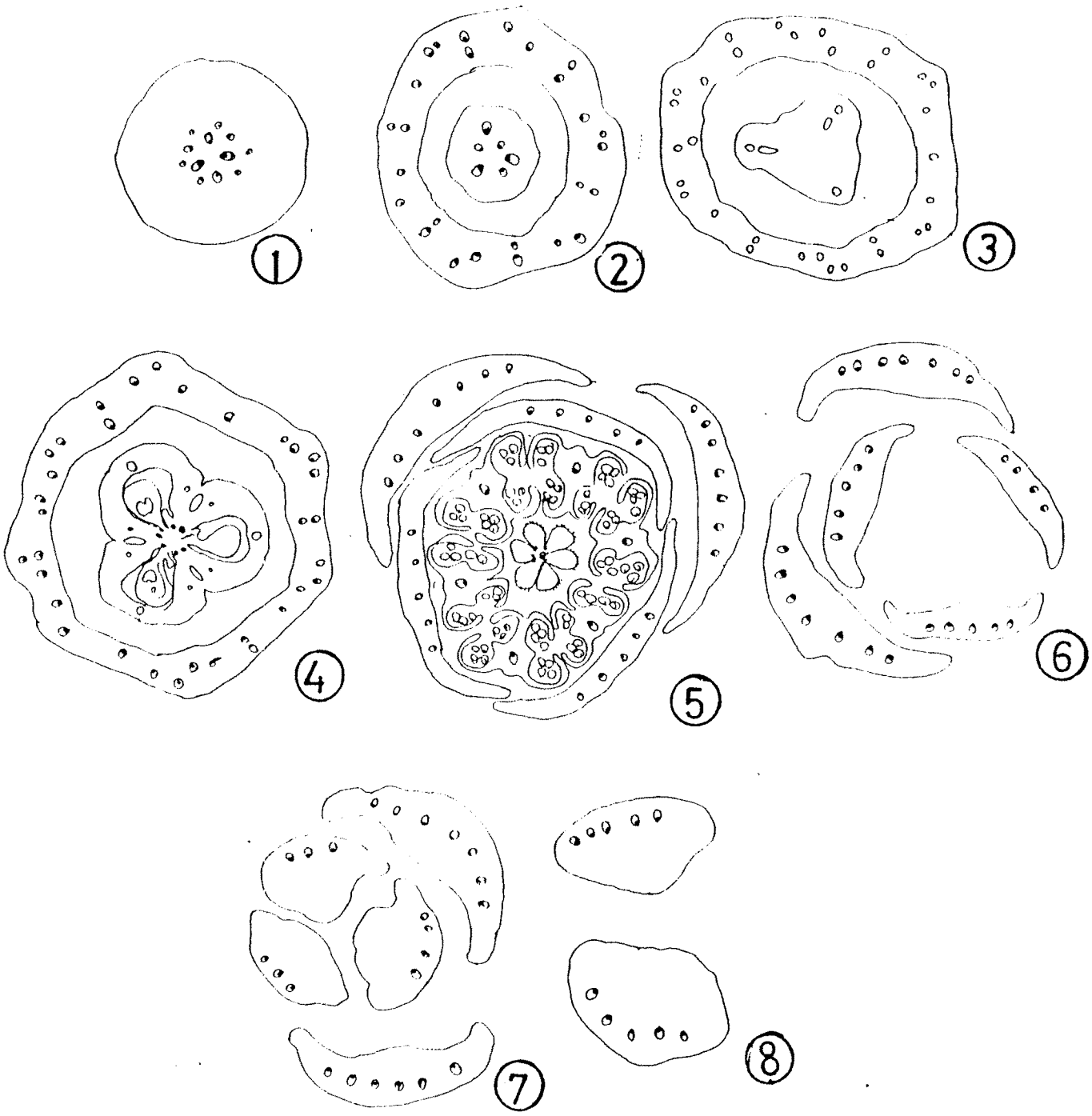
TEXT FIG - XIII



Text Fig. XIV figs. 1 - 8

Showing floral anatomy of D. maharashtrensis (a form with coriaceous bracts) x 20

TEXT FIG - XIV



one is 5 nerved.

Thus the vascular anatomy of the flower of genus Dipcadi is simple. The course of vasculature remains same in all the species studied. The difference are seen only in number of vascular traces per perianth lobe and the level at which the perianth parts and filaments separate.

***

D) EMBRYOLOGY

All the species of Dipcadi have typically trimerous flowers with 6 lobed perianth, 6 stamens and 3 carpels. The tricarpelly gynoecium is usually conspicuosly 3 angled. The ovary has a long style and trilobed stigma with numerous stigmatic papillae. The style is hollow lined with transmitting tissue. Raphides are present in ovary wall. Septal nectaries are present inbetween carpels.

(a) Floral Nectaries :

There are 3 septal nectaries in gynoecium (Text fig. XV, fig.1). They start appearing form base of gynoecium where ovules start appearing and disappear at the distal end of ovary. The cells of septal nectaries are slightly larger than the adjoining cells (Text fig.XV, Fig.2-5). The cells contain dense cytoplasm and stain deep by PAS reaction as well as by other stains like Hematoxylin and fast green. The nectaral cavity is surrounded by 2-3 layers of cells secreting nectar. The cells are radially elongated. The nectaries start developing at megaspore mother cell stage. They are fully developed when 8 nucleate embryo sac is developed (Text fig.XV, Fig.5). When flower opens, nuclei in the cells lining the septal cavity of the nectaries begin to disintegrate (Text fig.XV, Fig.6). After fertilization the nectaries get completely disorganised.

...69...

Text Fig. XV figs. 1 - 10

Showing septal nectaries, stigmatic papillae and transmitting tissue of D. concanense .

Fig. 1 - showing three septal nectaries x 350

Fig. 2-5 - showing septal nectaries during megasporogenesis and development of femal gametophyte x 350

Fig. 6 - Disorganised spetal nectary during embryogeny x 350

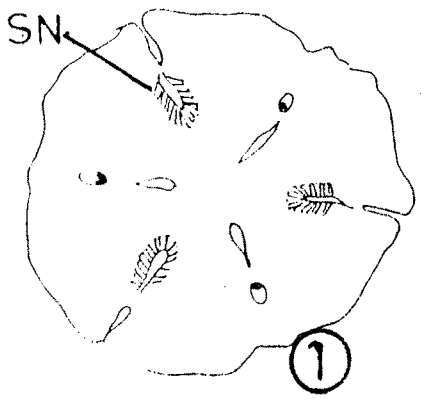
Fig. 7 - T.S. of stigma showing hollow style and stigmatic papillae x 350

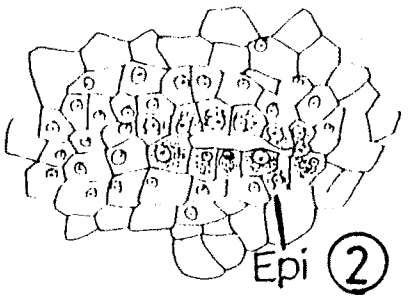
Fig. 8 - Stigmatic papillae before pollination x 350

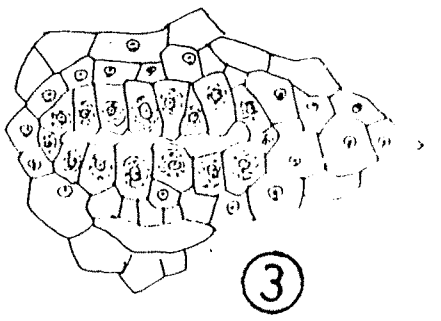
Fig. 9 - Stigmatic papillae during pollination x 350

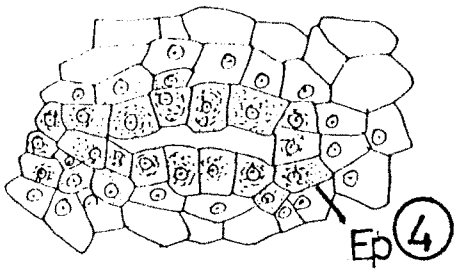
Fig. 10 - Stylar canal with transmitting tissue x 180

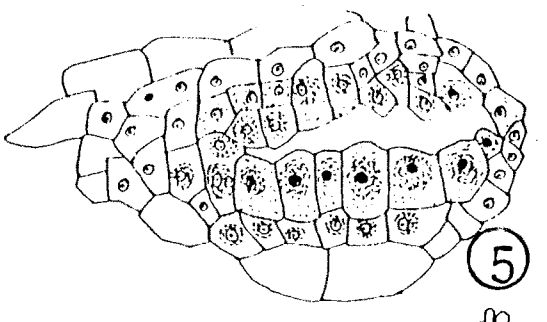
TEXT FIG - XV

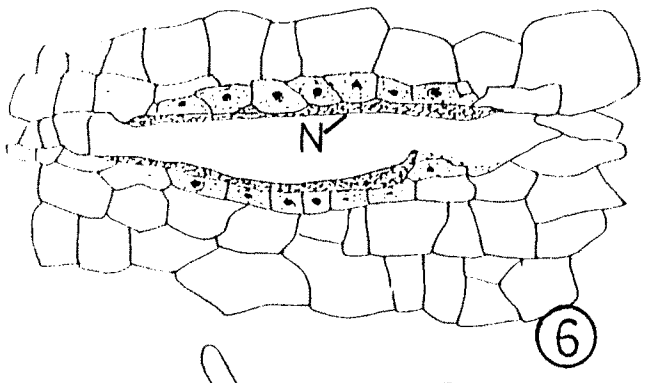


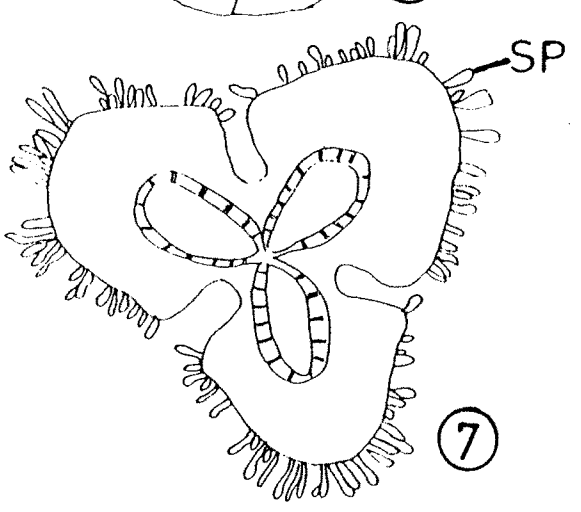


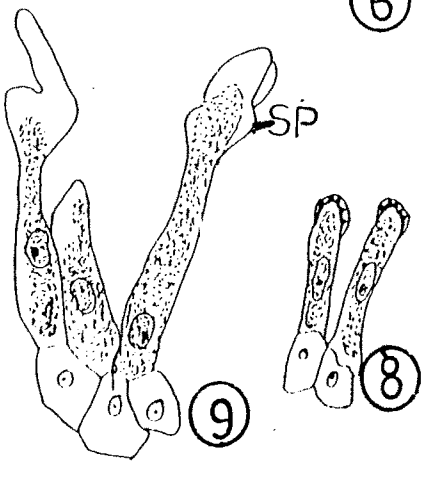


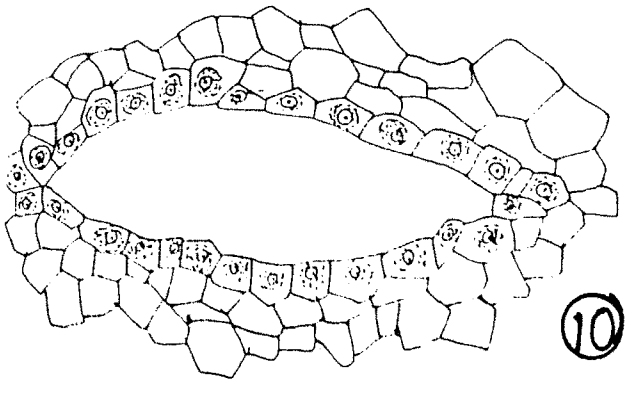












(b) Style and Stigma :

The style is long and hollow. The stylar canal is lined by single layer of transmitting tissue (Text fig.XV, fig.7 & 10). The stylar canal is triradiate in shape (Text fig.XV,fig.7).

The stigma is initially trilobed which becomes 6-lobed in distal part. The stigmatic lobes possess numerous papillae (Text fig.XV,fig.8-10). The stigmatic papillae are unicellular, uninucleate and clavate (Text fig. XV,fig.8). They posses dense cytoplasm and nucleus is found at middle region. Ovules give strong PAS reaction and are rich in carbohydrates. Ovary as well as ovules give poor reaction for protins. Starch starts accumulating during development of ovule. It reaches to maximum at the time of mature embryo sac. The outermost layer of nucellus becomes fully packed with larger starch grains. Then during further development this starch is utilised by the growing embryo.

(c) Phenology,anthesis and pollination :

After first monsoon showers during June the bulbs sprout out producing leaves first. During begining of July the young inflorescences start coming out and flowering is observed from mid July to August. Each inflorescence bears 3-6 flowers. The flowers are shining pure white. They range

...70...

in size from 3 to 4 cm in length. They have mild sweet smell and are entemophilous. Anther dehiscence takes place in bud condition before opening of flower. Fruiting is observed in August. Fruits mature in about one month and capsule dehiscence is seen at the end of August or begining of September. The seeds have no dormancy. They germinate immediately after dehiscence and form small bulbs. Young plants survive the dry season in the form of small bulbs. The above ground parts dieoff in September and bulbs remain dormant from September till June when monsoon starts.

(d) Microsporangium and Microsporogensis :

There are six fertile stamens. The anthers are tetrasporangiate, T.S. of young anther is four lobed. (Plate X fig.1), One or two celled archesporium arises at each corner of lobes (Text fig.XVI,fig.1 & 2).Archesporial cell divide transversely to form outer primary parietal layer and inner primary sporogenous initial. The cells of primary parietal layer divide to form a second layer (Text fig.XVI, fig. 3 & 4) and the cells of second later again divide transversely to form in all 4 layers (Text fig.XVI,fig.5 & 6) (Plate X, fig.2). Thus the wall of anther is 4 layered consisting of epidermis,endothecium, middle layer and tapetum (Plate X, fig.3 & 4). During further development of sporogenous cells the middle layer gets crushed (Text fig. XVI, fig. 7 & 8 , Plate X fig. 5 & 6) and fibrous thickenings

...71...

start developing in the walls of cells of endothecial layer. Similar thickening also develop in other cells adjoining endothecium towards the connective (Text fig.XVI,fig.9, Plate fig.9 & 10). Initially the tapetal cells are uninucleate and have dense cytoplasm (Text fig.XVI fig.6 Plate X fig.2). Afterwards when microspore mother cells enter in prophase, the tapetal cells become binucleate (Text fig. XVI, fig. 7 & 8, Plate X fig. 5). It is a prominent part of anther during microporogensis (Plate X fig. 3 to 6). The tapetal cells start degenerating at microspore tetrad stage (Plate X fig.8). The cells degenerate as the microspores separate and enlarge in size. The tapetum is of secretary type.

Microsporogensis is normal. Six bivalents were seen during diakinesis of mocrospore mother cells (Photoplate VI fig. 2 to 4). Remaining stages of meiosis were found to be normal. Microspore mother cells showed successive division generally giving rise to isobilateral tetrads. As the microspore grow theyseparate. The nucleus of the microspore comes to lie at one side of the pollem grain. The nucle us divides into two forming a generative cell and a vegetative cell. The pollen grains are shed in two nucleate condition. The pollen grains are large and have reticulate ornamentation. Anther dehisces longitudinally by a well organised stomium (Text fig.XVI fig.9 , Plate X fig. 9 & 10).

...72...

Text Fig. XVI figs 1 - 9

Showing microsporogensis in D. concanense

Fig. 1-2 - showing archesporial cell x 350

Fig. 3-4 - showing primary parietal, second layer and sporogenous cells x 350

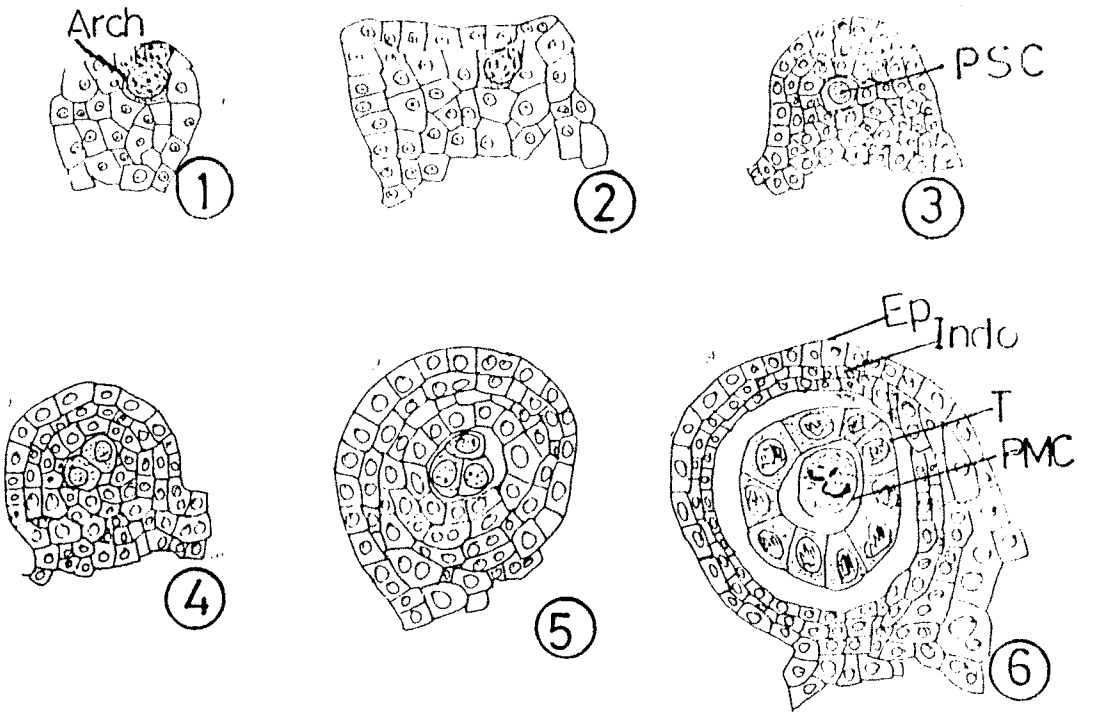
Fig. 5-6 - showing wall layers and sporgenous cell x 350

Fig. 7 - showing epidermis, endothecium, crushed middle layer, prominent tapetum and microspore mother cells x 350

Fig. 8 - showing microspore mother cell at diakinesis x 350

Fig. 9 - showing dehisced anther and endothecium with thickening x 350

TEXT FIG - XVI



(e) Megasporagium and Megasporogensis :

The ovary is tricarpellary, syncarpous, triloculed with many ovules in two rows in each locule on axile placenta (Plate XI. fig.1 to 3). Ovules are anatropus, bitegmic and crassinucellate. Initially ovules arise as small mounds on lateral side of placenta which grow outwords (Text fig.XVII, fig. 1 & 2 , Plate XI, fig.1). During further development ovules undergoe a curvature of 90° and becomes anatropous (Plate XI, fig.1-8). The inner integument makes its appearance when the megaspore mother cell is being formed (Text fig.XVII, fig.1 & 2 , Plate XI, fig. 4) whereas the outer integment differentiates when the megaspore mother cell undergoes meiotic division (Text fig. XVII, fig.4 , Plate XI, fig.6). The micropyle is formed by the inner integument (Text fig.XVII, fig.8). The inner integument is two layered except in the apical region where it is 3 layered. After fertilization and during embryo development the outer integument over grows the inner integument and completely surrounds the endosperm and embryo. The funicular strand extends upto the base of the nucellus (Text fig.XVII, fig.10 , Plate XII,fig.9) where it gets connected to a group of nucellular cells called hypostase.

Initially ovules arise as small mounds on lateral

...73...

side of placenta. Before integument differentiation a hypodermal archesporial cell with dense cytoplasm and prominent nucleus gets differentiated (Text fig.XVII, fig.1). It soon divides periclinally forming outer primary perietal cell and an inner megaspore mother cell (Text fig. XVII , fig. 1a & 2 , Plate XI,fig.1-3). The primary parietal cell gives rise to 2-3 layered parietal tissue. The megaspore mother cell gradully increases in size and elongates considerably (Text fig.XVII, fig.3) (Plate XI, fig.4-6). The meiosis of megaspore mother is normal. First division in megaspore mother cell gives rise to dyad (Text fig.XVII, fig.4b) (Plate XI,fig.7) and second to linear tetrad of 4 megaspores (Text fig.XVII,fig 5 , Plate XI,fig.8-9). T shaped tetrad observed in D. montanum were not observed in this species. The lower most chalazal megaspore of the tetrads is functional and gives rise to a female gametophyte and the micropylar three megaspore degenerate (Text fig.XVII, fig.6) (Plate XI, fig. 10-12).

(f) Female gametophyte :

The chalazal megaspore of the tetrad enlarges in size and a big vacuole appears in the centre of megaspore. During enlargement of functional megaspore, the inner layers of nucellus are digested and absorbed by growing megaspore.

...74..

The functional megaspore undergoes first mitotic division giving rise to binucleate embryo sac (Text fig.XVII,fig.7, Plate XII, fig.1-4). Out of two nuclei one moves to the micropylar end and other to the chalazal end and cytoplasm is restricted to periphery enclosing a large vacuole at centre (Text fig.XVII, fig.7 , Plate XII,fig.1-4). Further, each of the nucleus undergo second mitotic division giving rise to four nucleate embryo sac with two nuclei at micropylar end and two nuclei at chalazal end (Text fig.XVII, fig. 8 & 9 , Plate XII, fig. 5-7). There is large central vacuole in four nucleate embryo sac. After third mitotic division 4 nuclei are formed at micropylar end and 4 at chalazal end (Plate XII, fig.8). These soon organise into egg, apparatus, polar nuclei and antipodals (Plate XII, fig.9).

The mature female gametophyte consists of egg apparatus, two polar nuclei and three antipodals. The egg apparatus consists of two synergids and egg hidden between the synergids (Plate XII, fig.9). The two polar nuclei soon fuse and form secondary nucleus which lies above the three antipodals (Text fig.XVII, fig.10 , Plate XII, fig.9). The three antipodals lie in a pouch of embryo sac at chalazal end (Plate XII, fig.9). The antipodals in pouch vary in their arrangement.

...75...

Text Fig. XVII figs. 1 - 10

Showing megasporogensis and female gametophyte development in *D. concanense*

Fig. 1a - Hypodermal archesporial cell x 350

Fig. 1b and 2 - Archesporial cell cutting off the parietal cell x 350

Fig. 3 - Megaspore mother cell enlarging x 350

Fig. 4a - Megaspore mother cell at diakinesis x 350

Fig. 4b - Dyad x 350

Fig. 5 - Linear tetrad of 4 megaspores x 350

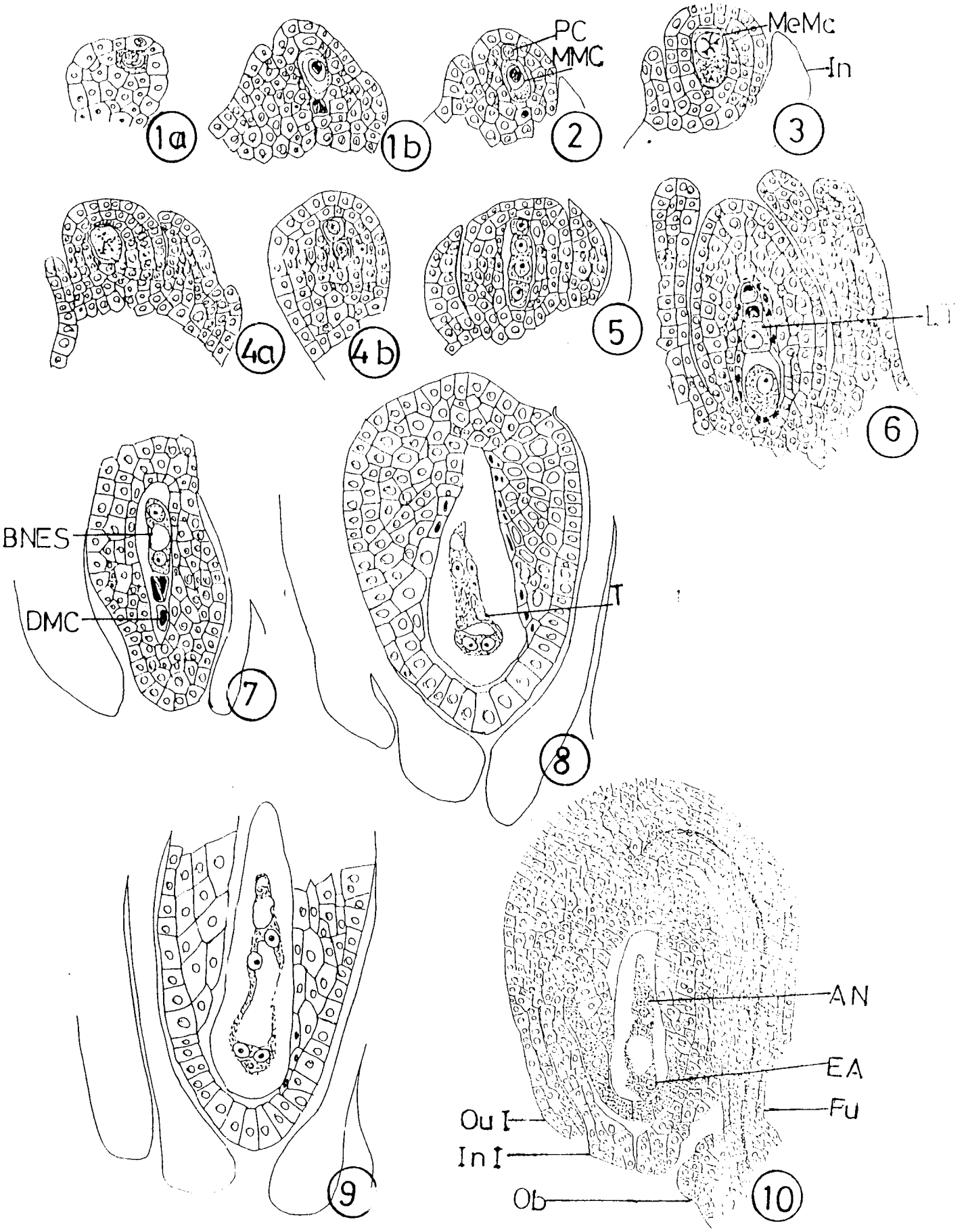
Fig. 6 - Chalazal megaspore enlarging and micropylar three megaspore showing signs of degeneration. x 350

Fig. 7 - Binucleate embryo sac x 350

Fig. 8-9 - Four nucleate embryo sac x 350

Fig. 10 - Ovule with mature embryo sac x 180

TEXT FIG - XVII



An elevated mound like out growth is developed at the base of funiculus on placenta which is lined by columnar epithelial cells with dense cytoplasm and dark staining ability. It forms a bridge for pollen tubes to enter in the micropyle of ovule. It is a obturator guiding pollen tubes towards micropyle of the ovules (Text fig.XVIII fog.10 , Plate XII,fig.4,7,9). Pollen tubes enter through micropyle and enter into one of the synergids. The pollen tube persist in micropyle for long time (Text fig. XVIII, fig.1 , Plate XIII, figs.3,4,5 & 8).

(g) Endosperm and Embryo development :

All the stage in development of endosperm and embryo have not been studied. The development of endosperm is of the helobial type. The zygote enlarges and the vacuole at micropylar end disappear (Text fig. XVIII, fig.1 , Plate XIII, fig. 1 & 3). The zygote divides by transverse wall forming small apical cell (Ca) and large basal cell (Cb) (Text fig. XVIII, fig.2). The apical cell divides transversally giving rise to 2 cells. Thus 3 celled embryo is formed (Plate XIII. fig.4). Sometimes linear embryo of 4 cell is formed (Text fig.XVIII, fig.3).(Plate XIII,fig.5). The apical cells undergoes vertical divisions forming quadrant and octant (Plate XIII, fig.6). Then globular embryo is formed (Text fig.XVIII, fig.4,6 , Plate XIII,fig.7). Although complete embryo development have not been studied

...76...

Text Fig. XVIII figs. 1 - 6

Showing stages in development of embryo.

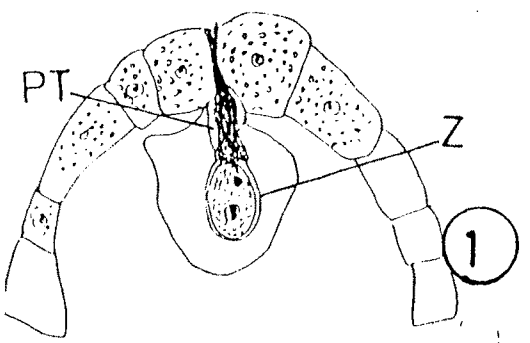
Fig. 1 - Zygote and persistant pollen tube x 350

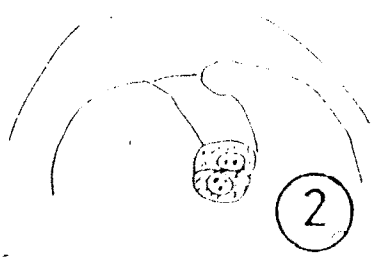
Fig. 2 - showing division of zygote into Ca and Cb x 350

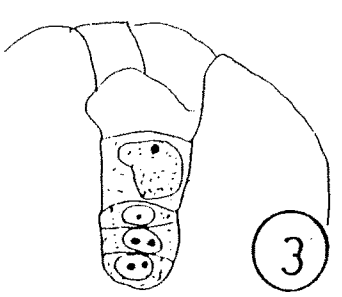
Fig. 3 - Linear embryo of 4 cells x 350

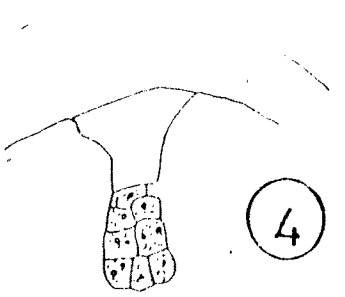
Fig. 4-6 - stages in development of embryo x 350

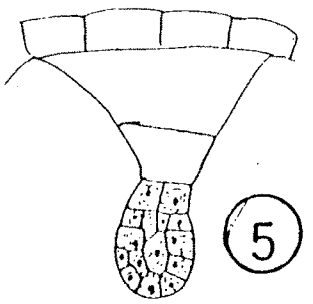
TEXT FIG - XVIII

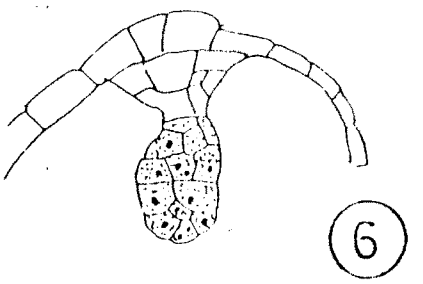












in present investigation, Mahabale and Chennaveeraiah (1961) have reported caryophyllad type of embryo development in genus Dipcadi.

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