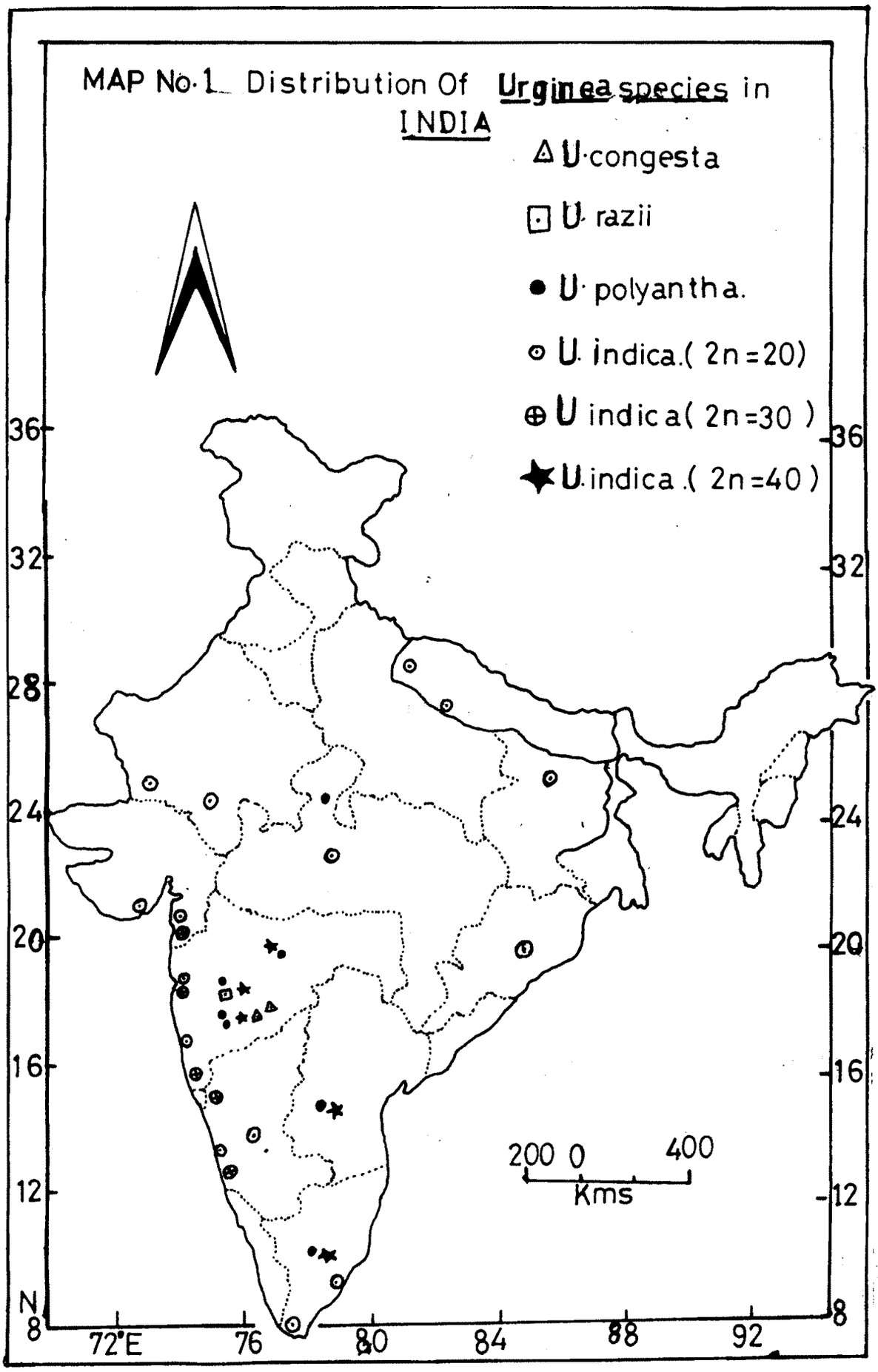
OBSERVATIONS

1) Morphology :

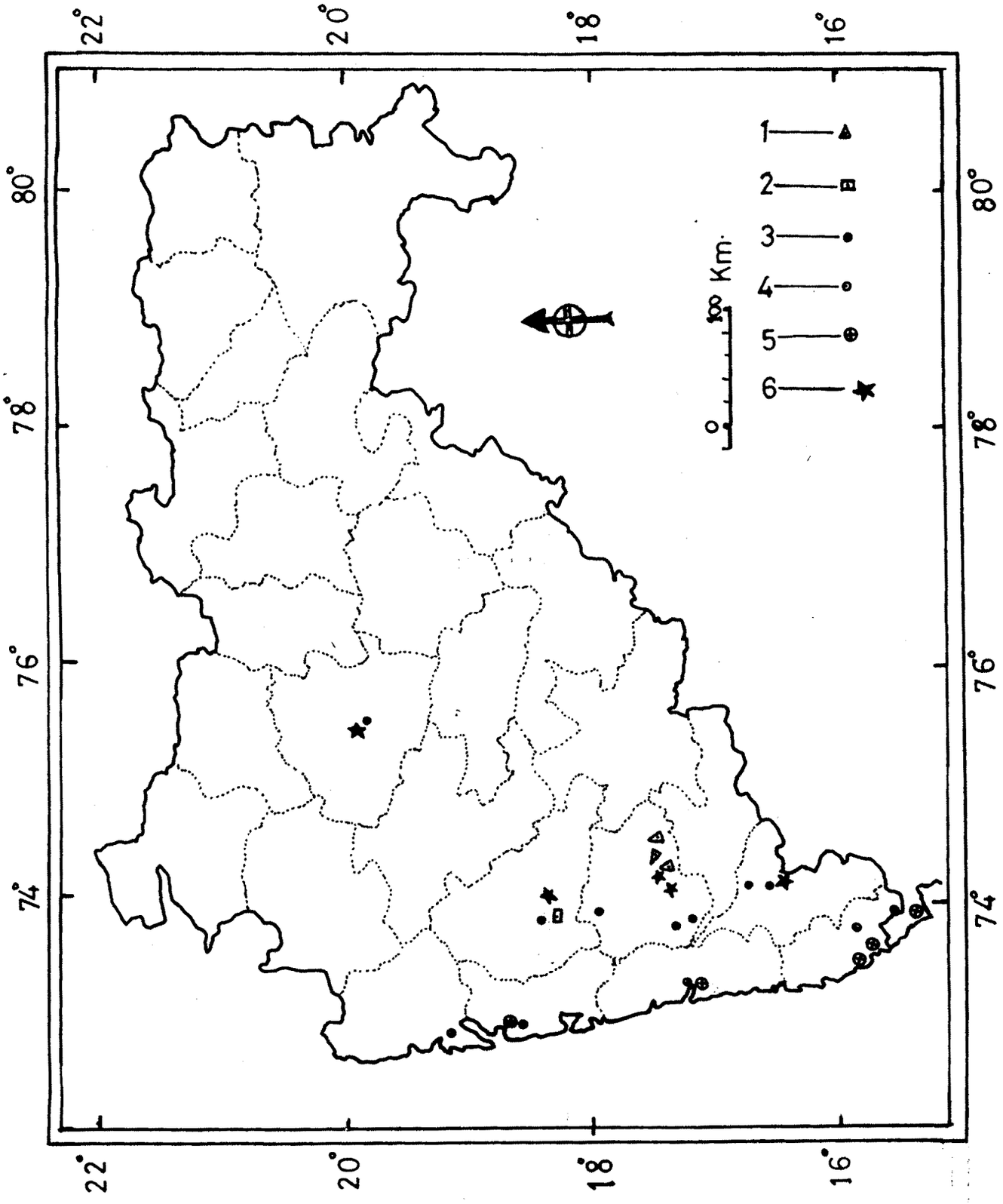
All the Indian species of Urginea Steinhl. have been reported from Maharashtra. These species except U. polyphylla have been collected from various localities (Table 3) in Maharashtra and are under cultivation in Botanical gardens of the department. The distribution of the different species of Urginea in India and Maharashtra have been shown in Map-1 and Map-2 respectively. The genus Urginea is highly polymorphic and most of the descriptions of Indian species are based on herbarium specimens and therefore, detailed descriptions of different species based on observations in the field and on living plants under cultivation are given below. Observations on vegetative and floral characters of different species of Urginea are given in Table 4, 5 and 6 and shown graphically in Fig.2 and 3.

Diagnostic characters of the genus Urginea :

Scapigerous herbs with tunicated bulbs; leaves hysteranthus or synanthus, radical, lanceolate, lorate, sessile, parallel nerved, glabrous; scape narrow, long, terete, glabrous, stiff, naked; inflorescence racemose on usually long leafless scape; flowers usually drooping, small, bisexual, hypogynous, campanulate, bracteate, bracts minute, solitary, deltoid or lanceolate, acute, often-spurred and evanscent; pedicels long or short, often filiform; perianth lobes 6, into two whorls


MAP No. 1 Distribution Of Urginea species in INDIA
Δ U. congesta
⊡ U. razii
● U. polyantha.
⊙ U. indica.(2n=20)
⊕ U indica(2n=30)
★ U. indica .(2n=40)
36
32
28
24
20
16
12
N 8
72°E
76
80
84
88
92
200 0 400
Kms

MAP No-2 Distribution of *Urginea* species in MAHARASHTRA



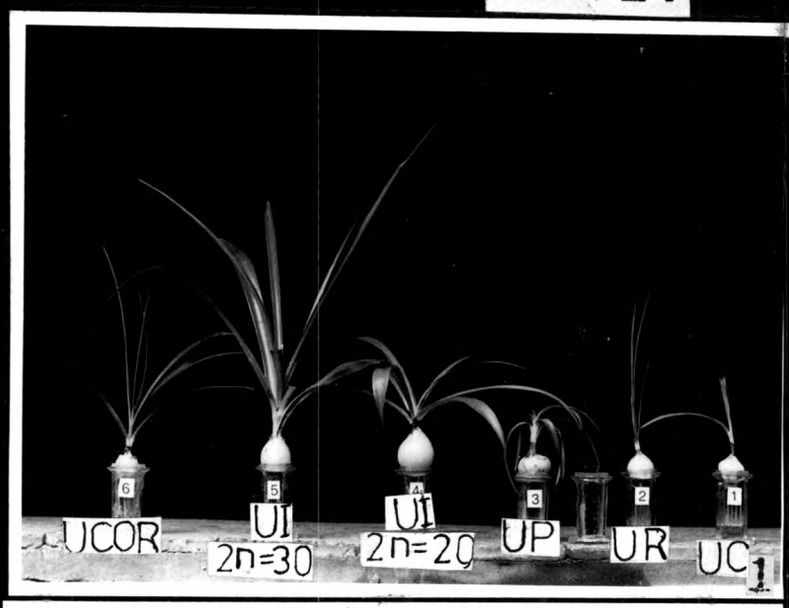
1) *U. congesta* 2) *U. razii* 3) *U. polyantha* 4) *U. indica* (2n = 20)
5) *U. indica* (2n = 30) 6) *U. indica* (2n = 40)

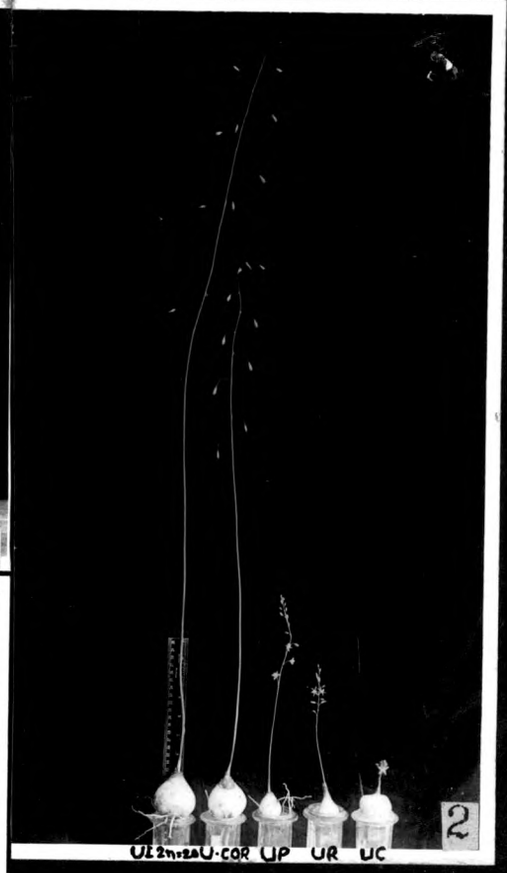
Photoplate I (1-4) : Showing plant parts of *Urginea* sps.

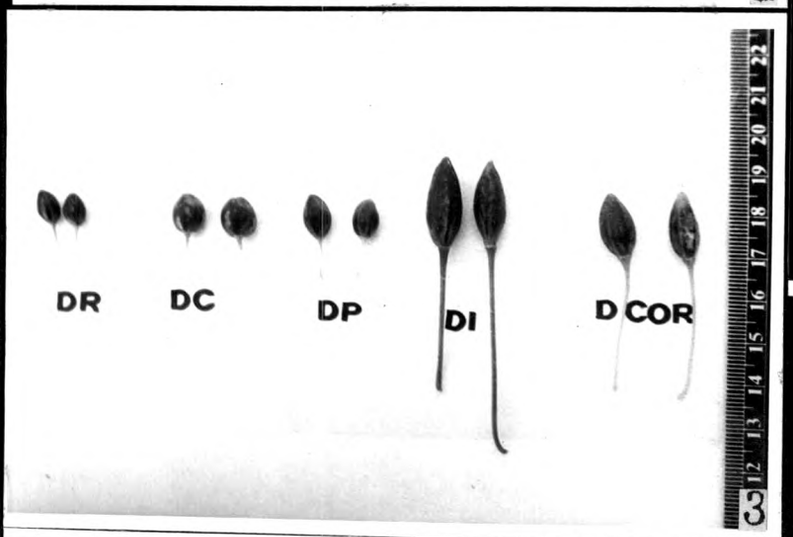
1) Plants in vegetative stage.
2) Plants in flowering stage.
3) Capsules.
4) Seeds.

(UC = *Urginea congesta*; UR = *U.razii*;
UP = *U.polyantha*; UI = *U.indica* (2n = 20);
UI = U.indica (2n = 30); U.CoR = *U.indica* (*U.coromandeliana*) 2n = 40).

PLATE-1


6
5
4
3
2
1
UCOR
UI
2n=30
UI
2n=20
UP
UR
UC
1


UI 2n=20 U-COR
UP
UR
UC
2


DR
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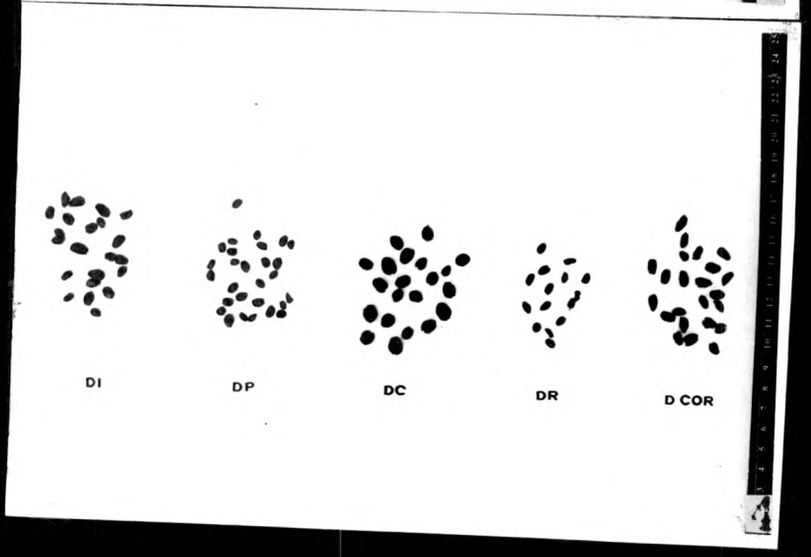
3


DI
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of three each, petaloid, subequal, outspreading, free to the base; perianth lobes lanceolate, oblong, obtuse or acute, scarious, 1-3 nerved at the centre, bearded at the apex; stamens 6, adnate at or near the base of the perianth lobes; filament filiform, straight, flattened at base, narrowed or thickened to the apex; anthers oblong or linear, bilocular, dorsifixed, introse, dehiscing longitudinally; pollen grains oblong, monocolpate, reticulate; pistil tricarpellary, syncarpous, superior; ovary ovate, ovate-oblong, sessile, trilocular; ovules numerous in each cell on axile placenta, anatropous, bitegmic, crassinucellate; style long, straight, rarely bent, tapering towards base; stigma subglobose or flat, broad, obconic, bearded, trilobed; fruit an oblong or globose, trilocular, triseptate, triquetrous loculicidal capsule; seeds many in each locule, compressed, superposed, oblong, winged, shining, testa black; embryo large albumen fleshy.

1. U.congesta (Table 4,5 & 6; Fig.1,2 & 3; PhotoplateI1-4 UC):

A bulbous scapigerous hysteranthus {as against synanthus described by Hooker (1894), Gamble (1930) and Deb and Dasgupta (1974, 1981)} herb (Photoplate I 1-UC); bulb 3.8 ± 1.4 cm in diameter, 4.2 ± 1.2 cm in height with short neck of 1.9 ± 1.4 cm in length, ovoid, subglobose or umbonate; scale fleshy, soft, white; basal rooting disc 0.99 ± 0.15 cm in diameter with poor ability to produce roots; leaves usually three per plant, spreading on ground, often twisted, 20.5 ± 5.2 x 1.03 ± 0.25 cm, dark

green; scape 6.4 ± 1.02 cm in length with 2.3 ± 0.41 mm in diameter at base, slender, purplish-green glabrous;inflorescence simple densly congested raceme (Photoplate I 2-UC) 12.9 ± 6.6 flowered; flowers clustered congested, ascending, suberect, companulate bracteate, 1.57 ± 0.26 cm in diameter, opening around 10 in morning and closing by afternoon, shortly pedicillate; pedicels short 3.6 ± 1.5 mm long, suberect; bracts 1 mm long, acute, persistent; perianth segments 6, joined at base in two whorls; perianth lobes of outer whorl larger, 7.2 ± 1.07 x 3.3 ± 0.6 mm, oblong, of inner whorl slightly smaller, 6.9 ± 1.0 x 3.0 ± 0.6 mm, both one nerved, nerves dark purple, perianth lobes bearded and reflexed in open flower; stamens 6, free, 5.2 ± 0.8 mm long, adnate to perianth lobes at base; filaments flat, broad at base, tapering upwards, 3.5 ± 0.5 mm long; anthers versatile, introse, dorsifixed, greenish-yellow, 3.5 ± 0.4 x 1.4 ± 0.2 mm; pollen grains 65 x 62 µm, microreticulate, monocolpate; pistil tricarpellary, syncarpous, superior, 6.7 ± 0.7 mm long; triloculed, 3.2 ± 0.4 x 2.1 ± 0.2 mm, 25.5 ± 3.3 ovuled; style slender, 3.6 ± 0.6 mm long; stigma slightly swollen, trilobed, 0.8 ± 0.2 mm in diameter; capsule 9.5 ± 2.1 x 7.8 ± 1.0 mm, globose trigonous (Photoplate I 3-UC) trilocular, loculicidal, 12.6 ± 4.6 seeded; seeds 7.7 ± 0.13 x 6.2 ± 0.7 mm, nearly round or elliptic, broadly winged, compressed, testa black, shining (Photoplate I 4-UC).

Distribution : Maharashtra (Map-2) : Singnapur, Piliv, Kartikiswami, Vagir-gad. Kerala : Osmania University Campus, Hyderabad. Malabar Sea Coast (Gamble).

Phenology : Flowering and fruiting before leaves in the months of March-April. After first rains during June, leaves are produced which die off by about September-October and bulbs remain in dormant condition for four-five months from October to February. The bulbs starts flowering in month of March.

Ecological Note : It grows in rocky-open grounds in arid zones of Maharashtra (Map-2). It seems to be most slow growing species among Indian species. It can be very easily identified from other Indian species by its short congested inflorescence. It is difficult to locate the species in fields in flowering because of short ash-coloured inflorescence which matches with soil color.

2. U.razii (Table 4,5 & 6, Fig.1.2,3; Photoplate I 1-4 UR) :

A bulbous herb (Photoplate I 1-UR), scapigerous, hysteranthus; bulbs 3.2 ± 0.9 cm in diameter, 4.2 ± 1.3 cm in height, ovate or subglobose with 2.4 ± 1.2 cm long neck; scales white; basal rooting disc 5.3 ± 1.9 mm in diameter with low ability to produce roots; leaves 4.9 ± 1.4 per plant, erect or ascending; narrowly linear, fleshy, grooved above, broadest at base, acute at apex, glabrous, 15.8 ± 4.9 cm x 3.2 ± 0.09 mm, green; scape (Photoplate I 2-UR) 15.7 ± 3.3 cm in length with 1.64 ± 0.26 mm basal diameter, slender, reddish-green, glabrous; inflorescence simple raceme, 14.8 ± 5.24 flowered; flowers ascending, pedicelled, bracteate, brownish, 1.46 ± 0.2 cm in diameter, opening around 10 in morning and closing by 4 in evening; pedicels 0.62 ± 0.22 cm

long, spreading, ascending; bracts 1.5 x 1 mm, spurred, evanescent; perianth segments 6, joined at base, in two whorls; Perianth lobes of outer whorl 6.58 ± 0.81 x 2.66 ± 0.35 mm, linear, Perianth lobe of inner whorl slightly smaller 6.3 ± 0.9 x 2.04 ± 0.23 mm, linear, both one-herved, brownish, bearded and reflexed at apex in open flower; stamens 6, free, 5.2 ± 0.38 mm long, adnate to perianth at base, filaments flat at base, cylindrical and narrowed at apex, 3.59 ± 0.36 mm long; anthers versatile, introrse, dorsifixed, yellow 2.8 ± 0.46 x 1.24 ± 0.63 mm; pollen grains 73 x 69 um, microreticulate, monocolpate; pistil tricarpellary, syncarpous, superior, 6.09 ± 0.49 mm long; ovary triloculed, 3 ± 0.24 x 2.02 ± 0.24 mm, 20.6 ± 2.3 ovuled; style slender, straight, 3.02 ± 0.4 mm long; stigma swollen, trilobed, 0.52 ± 0.04 mm in diameter; capsule 7.86 ± 0.69 x 4.86 ± 0.69 mm, ovate, or elliptic-ovate, (Photoplate I 3-UR), trilocular, loculicidal, 9.08 ± 4.46 seeded; seeds 5.9 ± 0.57 x 3.7 ± 0.34 mm, broadly ovate or elliptic (Photoplate I 4-UR), winged, black, testa shining.

Distribution : Maharashtra (Map-2) : Diva ghat: so far it is reported from said locality and seems to be endemic to Maharashtra.

Phenology : It starts flowering and fruiting in March-April. After reproductive phase bulbs sprout in the month of June after first rains and vegetative growth continues upto September-October. By the end of October the leaves die off and bulbs remain dormant from November to February and starts flowering again in the month of March.

Ecological Note : It grows in rocky, open grounds on slopes in arid zone. Its reproductive ability is low and seems to be newly evolved species. It can be very easily identified by its narrowly linear fleshy leaves which are not found in any other Indian species.

3. U.polyantha (Table 4,5 & 6, Fig.1,2 & 3, Photoplate-I 1-4 UP) :

A bulbous, scapigerous, hysteranthus herb (Photoplate-I 1-UP); bulbs 3.9 ± 0.85 cm in diameter, 4.1 ± 0.9 cm in height with 1.7 ± 0.92 cm long neck, ovoid, subglobose or globose; scales white; basal rooting disc 1.6 ± 0.34 mm in diameter with median ability to produce roots; leaves 6.2 ± 2.2 per plant, usually spreading on ground often twisted, 20.11 ± 5.8 x 1.4 ± 0.57 cm green; scape (Photoplate-I 2-UP) 29.6 ± 8.2 cm in length with 2.8 ± 0.49 mm in diameter at base, slender, grayish-green, glabrous; inflorescence simple raceme, 23.2 ± 8.03 flowered, flowers dense, bracteate, pedicelled, brownish; 1.42 ± 0.12 cm in diameter, opening with sunrise and closing by 4 in evening; pedicels 8.3 ± 1.3 mm long, filiform, spreading, ascending; bracts deltoid, 1 mm long, persistent; perianth segments 6, joined at base in two whorls, perianth lobes of outer whorl 6.41 ± 0.56 x 2.95 ± 0.26 mm, oblong, perianth lobes of inner whorl slightly smaller, 6.25 ± 0.62 x 2.28 ± 0.31 mm, oblong, both one-nerved, brownish, bearded, reflexed at apex in open flower; stamens 6, 4.2 ± 0.52 mm long, adnate to perianth at base; filaments flat at base, cylindrical and narrowed at apex,

2.9 ± 0.29 mm long; anthers versatile, introrse, dorsifixed, greenish-yellow, 2.62 ± 0.31 x 1.33 x 0.11 mm; pollen grains 68 x 64 µm, microreticulate, monocolpate; pistil tricarpellary, syncarpous, superior, 5.07 ± 0.42 mm long; ovary triloculed, 3.06 ± 0.31 x 1.93 ± 0.16 mm, 26.4 ± 3.78 ovuled; style slender, straight or sometimes knee-shaped, 2.42 ± 0.34 mm long; stigma swollen, trilobed, 0.96 ± 0.15 mm in diameter; capsule 10.0 ± 1.26 x 5.97 ± 0.067 mm, ovoid-oblong (Photoplate-I 3-UP) or elliptisoid, triquetrous, triloculed, loculicidal, 14.55 ± 5.91 seeded; seeds 5.8 ± 0.64 x 4.05 ± 0.48 mm, broadly ellipsoid much compressed, winged, testa, black, shining (Photoplate-I 4-UP).

Distribution : Maharashtra : Poona, Panchgani plateau, Yelgaon, Saikade, Kolhapur, Kartikiswami, Singnapur, Mavashi-plateau, Panhala, Aurangabad; Karnataka : Munged, Dangi; Madhya Pradesh : Gwalior.

Phenology : It starts flowering and fruiting from February to March, After reproductive phase, bulbs sprout in the month of June after first rains and vegetative growth continuous upto September-October when leaves dry and bulbs remain in dormant phase upto February.

Ecological Note : It grows in rocky open grounds where the leaves spread on ground however, the plants growing in mountain areas, the leaves are erect or ascending. It shows good reproductive capacity. It resembles with U.indica in

morphology but is smaller in characters including pollen grains scape length, pedicel length, flower and fruit size. U.polyantha seems to be wide spread in Maharashtra.

4. U.indica (2n = 20) (Table 4,5 & 6, Fig.1,2 & 3, Photoplate-I 1-4 UI):

Bulbous, scapigerous, hysteranthus herb (Photoplate-I 1-UI); bulbs 4.6 ± 0.95 cm in diameter, 5.7 ± 1.04 cm in height with neck 1.0 ± 0.69 cm in length, globose, conical, ovoid, tunicated; scales white; basal rooting disc 2.4 ± 0.4 cm in diameter with strong ability to produce roots; leaves 8.9 ± 3.5 per plant, erect or ascending, 26.9 ± 7.5 x 3.1 ± 0.54 cm, green, linear-lanceolate or lorate, ensiform, narrowed towards base, glabrous, acute at apex; scape solitary, (Photoplate I 2-UI), 95.5 ± 8.3 cm in length with 3.93 ± 0.12 mm basal diameter, slender, purplish-red, glabrous, inflorescence simple, long, loose raceme, 18.82 ± 6.5 flowered; flowers loosely arranged, long pedicelled, drooping, bracteate, companulate, 2.09 ± 0.25 cm in diameter, opening at evening at about 6.0 0'clock and closing at about 6.0 0'clock in morning; pedicels long, 3.7 ± 0.84 cm long, outspreading or drooping, slender, filiform; bracts 1-2 mm long, deltoid, acute evanescent, often spurred, falling before flower maturation; perianth segments 6, connate at base in two whorls, acute or obtuse at apex, oblong-lanceolate; perianth segments of outer whorl larger, 10.1 ± 2.02 x 3.39 ± 0.3 mm, of inner whorl 9.57 ± 1.6 x 2.76 ± 0.31 mm, both one nerved, bearded

at apex, reflexed in open flower; stamens 6, 7.69 ± 0.86 mm long, adnate to perianth lobes at base; filaments flat at base, tapering and cylindrical upwards, 5.68 ± 0.46 mm long; lanthers versatile, introrse, dorsifixed, greenish-yellow or yellow, 3.37 ± 0.39 x 1.63 ± 0.13 mm; pollen grains 80 x 78 µm, macroreticulate, monocolpate; pistil tricarpellary, syncarpous, superior, 8.86 ± 0.87 mm in length; ovary triloculed, 5.22 ± 0.67 x 2.83 ± 0.23 mm, 52.5 ± 7.9 ovuled; style slender, 3.28 ± 0.35 mm long; stigma swollen, trilobed, 1.21 ± 0.16 mm in diameter; capsule 18.8 ± 2.8 x 6.1 ± 0.83 mm, oblong or ellipsoid (Photoplate-I 3-UI), trilocular, loculicidal, 23.48 ± 6.3 seeded; pericarp stiff, brittle brownish yellow; seeds 7.5 ± 1.56 x 4.69 ± 0.53 mm, oblong or obovate-oblong, compressed, winged, testa black, shining (photoplate-II-4-UI).

Distribution : Throughout India along coastal sandy regions (Map-1), Maharashtra (Map-2) : Wagreswari, Ganapati-pule, Malvan, Araunda, Vengurla, Goa.

Phenology : It starts flowering and fruiting from February and it is continued upto April end. After first rain in the month of June, the bulbs sprout and vegetative growth is continued upto October when leaves die off and bulbs remain in dormant phase in the months of November to February. In February bulbs again start flowering.

Ecological Note : In this species the flowers remain

opened during night. It generally grows along sea-coast in sandy soils and so far not found in eastern Maharashtra by the author. It is the robust species among Indian species.

5. U.indica (2n = 30) (Table 4,5 & 6, Fig.1,2 & 3; (Photoplate-I 1-UI (2n = 30)).

A bulbous, scapigerous, hysteranthus herb (Photoplate-I 1-UI) (2n = 30)); bulbs 5.7 ± 2.4 cm in diameter, 5.6 ± 1.5 cm in height with neck 0.9 ± 0.82 cm in length, globose, conical, tunicated with strong ability to propagate by means of daughter bulbs; scales white; basal rooting disc 2.2 ± 0.19 cm in diameter with prominent rooting ability; leaves 10 ± 3.2 per plant, erect or ascending, sub-bifarious, linear lanceolate or lorate, ensiform, narrowed towards base, glabrous, acute at apex, green, 50.3 ± 7.5 x 2.52 ± 0.89 cm; scape solitary, robust, 95.2.± 16.2 cm in length with 4.64 ± 0.98 mm basal diameter, purplish-white, glabrous; inflorescence long, simple, loose raceme, 21.5 ± 6.02 flowered; flowers loosely arranged, long padicelled, drooping or spreading, bracteate, campanulate, brown-purplish, 2.25 ± 0.21 cm in diameter, opening at about 6 O'clock in evening and closing by morning; bracts 1-3 mm long, deltoid, acute, evanescent, often spurred, falling before the flower maturation; pedicels 3.54 ± 0.6 cm long, slender, filiform, outspreading or drooping; perianth segments 6, connate at base in two whorls, acute or obtuse at apex, oblong-lanceolate, perianth segments of outer whorl larger, 10.8 ± 0.14 x 4.4 ± 0.48 mm, that of inner whorl smaller, 10.04 ± 0.11 x 3.55 ± 0.4 mm, both one-nerved, bearded at apex, reflexed in open

flower, stamens 6, 8.88 ± 0.15 mm long, adnate to perianth lobes at base; filaments flat at base, swollen cylindrical in middle and tapering upwards, 5.71 ± 0.35 mm long; anthers versatile, introrse, dorsifixed, greenish-yellow or yellow, 3.73 ± 0.63 x 1.59 ± 0.18 mm, pollen grains 66 x 56 µm, micro to macroreticulate, monocolpate with high pollen sterility and size variation; pistil tricarpellavy, syncarpous, superior, 9.9 ± 8.82 mm in length; ovary triloculed, 5.9 ± 0.79 x 3.08 ± 0.26 mm, 52.4 ± 7.8 ovuled; style slender, 3.98 ± 0.51 mm long; stigma swollen trilobed, 1.63 ± 0.17 mm in diameter. No fruiting has been observed.

Distribution : Triploid form of U.indica is mostly distributed (Map-2) along coastal line of India - Maharashtra (Map-2) : Alibag, Malvan, Ganpati-pule, Vengurla, Araunda, Goa.

Phenology : It starts flowering in the month of February and continuous upto April, however, due to triploid nature no fruit setting was observed. In the month of June the bulbs sprout out and continue vegetative growth upto October and then leaves die off. Bulbs remain dormant from November to February and start flowering in February.

Ecological Note : It grows along sea-coast in sandy soils. It is well adapted for saline habitat. As there is no seed-setting, it propagates through production of daughter bulbs which are exposed due to sand erosion and dispersed by various agencies mainly by water.

6. U.indica (2n = 40)

(Table 4,5 & 6; Fig.1,2 & 3; Photoplate-I 1-4 U 'COR) :

A bulbous, scapigerous, hysteranthus herb, (Photoplate-I 1-U'COR); bulbs 4.1 ± 1.08 cm in diameter, 4.7 ± 1.04 cm in height with neck 1.7 ± 1.3 cm in length, globose, conical ovoid, tunicated; scales white; basal rooting disc 1.6 ± 0.39 cm in diameter with good ability to produce roots; leaves 20.2 ± 11.2 x 1.39 ± 0.52 cm, erect or ascending or spreading on ground, green, linear lanceolate or lorate, ensiform, narrowed at base, glabrous, acute at apex; scape (Photoplate-I 2-UCOR) solitary, 42.5 ± 14.6 cm in length with 2.82 ± 0.61 mm basal diameter, slender, greenish-red, glabrous; inflorescence simple, loose raceme, 6.57 ± 2.8 flowered; flowers loosely arranged, long pedicelled, drooping, bracteate, campanulate, 2.11 ± 0.2 cm in diameter, opening at evening at about 6 O'clock and closing by morning; pedicels long, 2.76 ± 0.6 cm, outspreading or drooping, slender, filiform, bracts 1-3 mm long, deltoid, acute, evanescent, often spurred; perianth segments 6, in two whorls, three in each whorl, connate at base; perianth segments of outer whorl larger 9.31 ± 0.75 x 2.95 ± 0.29 mm,of inner whorl smaller, 8.96 ± 0.66 x 2.33 ± 0.24 mm, both one-nerved, acute or obtuse at apex, oblong-lanceolate, bearded at apex, reflexed in open flower; stamens 6, 7.4 ± 0.79 mm long, adnate to perianth lobes at base; filaments flat at base, swollen and cylindrical in middle, tapering towards apex, 5.24 ± 0.54 mm long; anthers versatile, introrse, dorsifixed, yellowish-green, 3.33 ± 0.46 x 1.5 ± 0.035 mm, pollen grains macroreticulate,

monocolpate, 83 x 79 µm, monocolpate; pistil tricarpellary, syncarpous, superior, 8.56 ± 0.55 mm long, 42.4 ± 7.1 ovuled; style slender, 3.49 ± 0.33 mm long; stigma swollen, trilobed, 1.86 ± 0.17 mm in diameter; capsule (Photoplate-I 3-UCOR), 16.2 ± 0.27 x 6.2 ± 0.1 mm, oblong or ellipsoid, trilocular, loculicidal, 13.7 ± 9.09 seeded; pericarp stiff, hard, brittle; seeds 7.56 ± 0.85 x 4.78 ± 0.48 mm, oblong or obovate-oblong, compressed, winged, testa black shining (Photoplate-I 4-UCOR).

Distribution : Widely distributed in fairly dry localities in India. Maharashtra (Map-2) : Aurangabad, Singnapur, Piliv, Kartikiswami, Diva Ghat, Kagal, Shivaji University Campus, Madras : Central and Eastern dry districts.

Phenology : It starts flowering and fruiting from February and flowering-fruiting is continued upto May. In month of June the bulbs sprout and vegetative growth is continued upto October-November. Then the leaves die off in October-November. Bulbs remain dormant from November to February when they again start flowering. Abnormal flowering is seen throughout year.

Ecological Note : In this species the blooming of flower is during night. It grows in open rocky grounds in dry districts of Maharashtra. It shows tendency to produce daughter bulbs and vegetative propagation through daughter bulbs is common.

Following key is suggested to identify different species

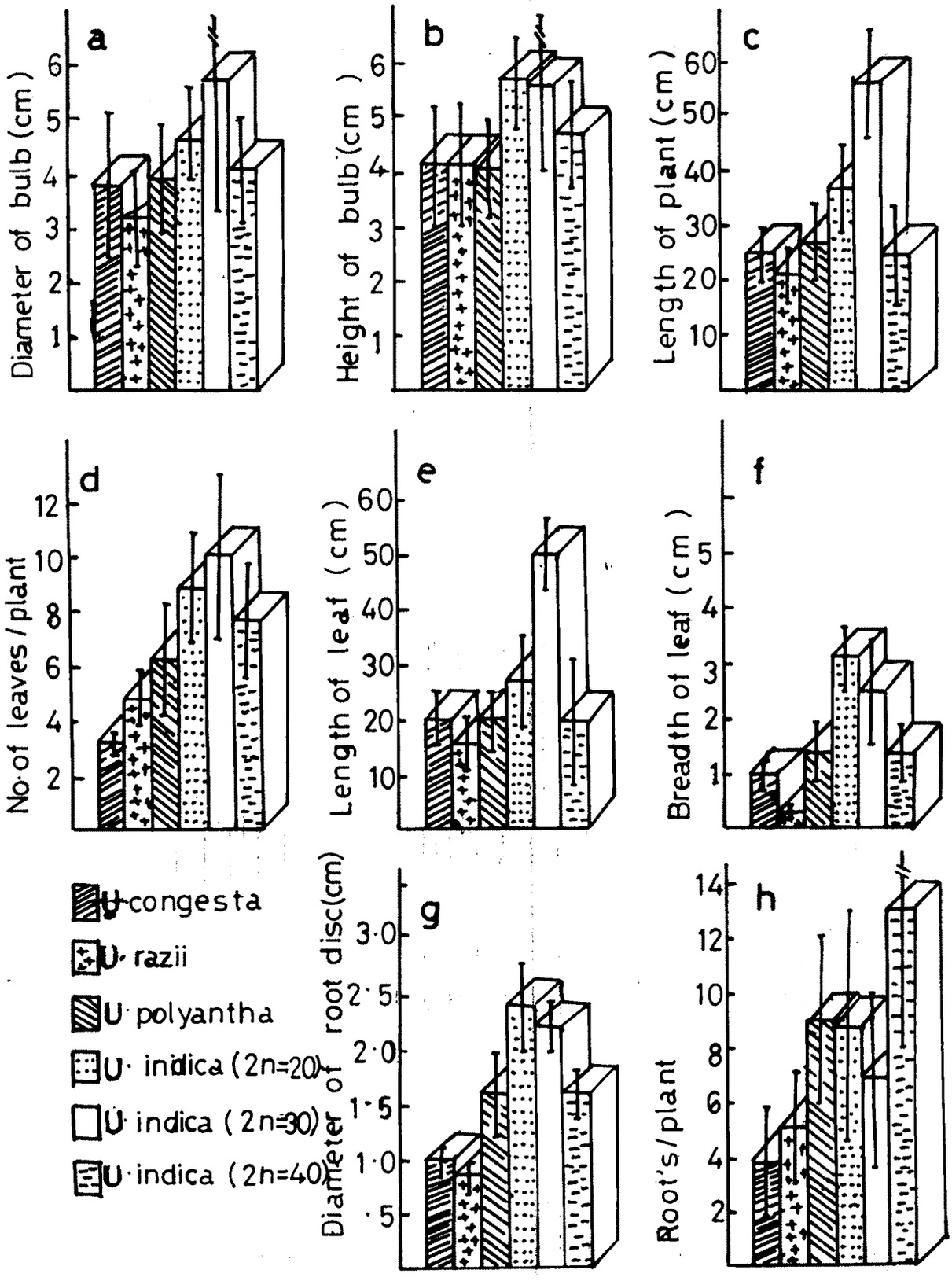


Fig-1 - Vegetative morphological characters of *Urginea* species

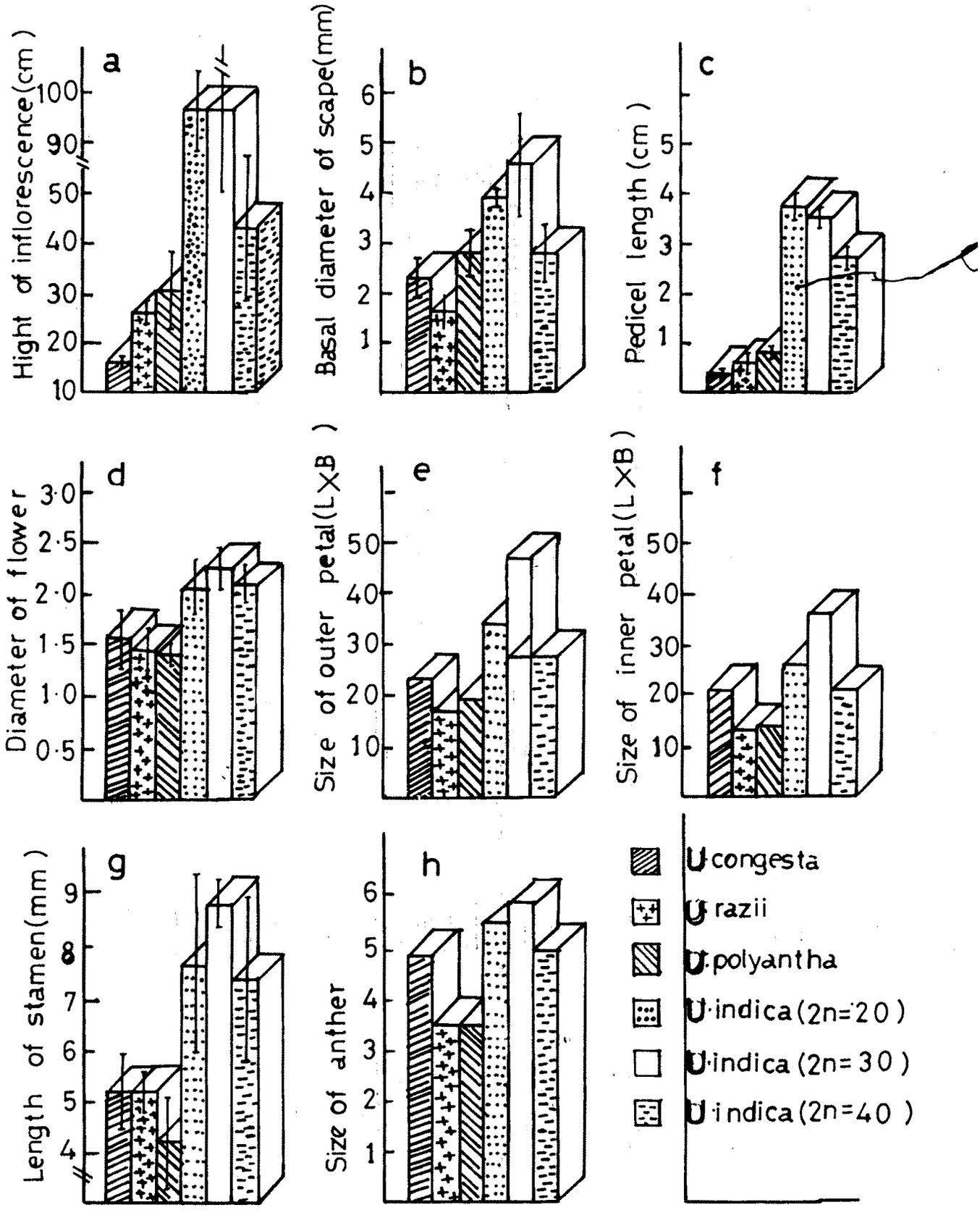


Fig. 2 - Reproductive morphological characters of Urginea species

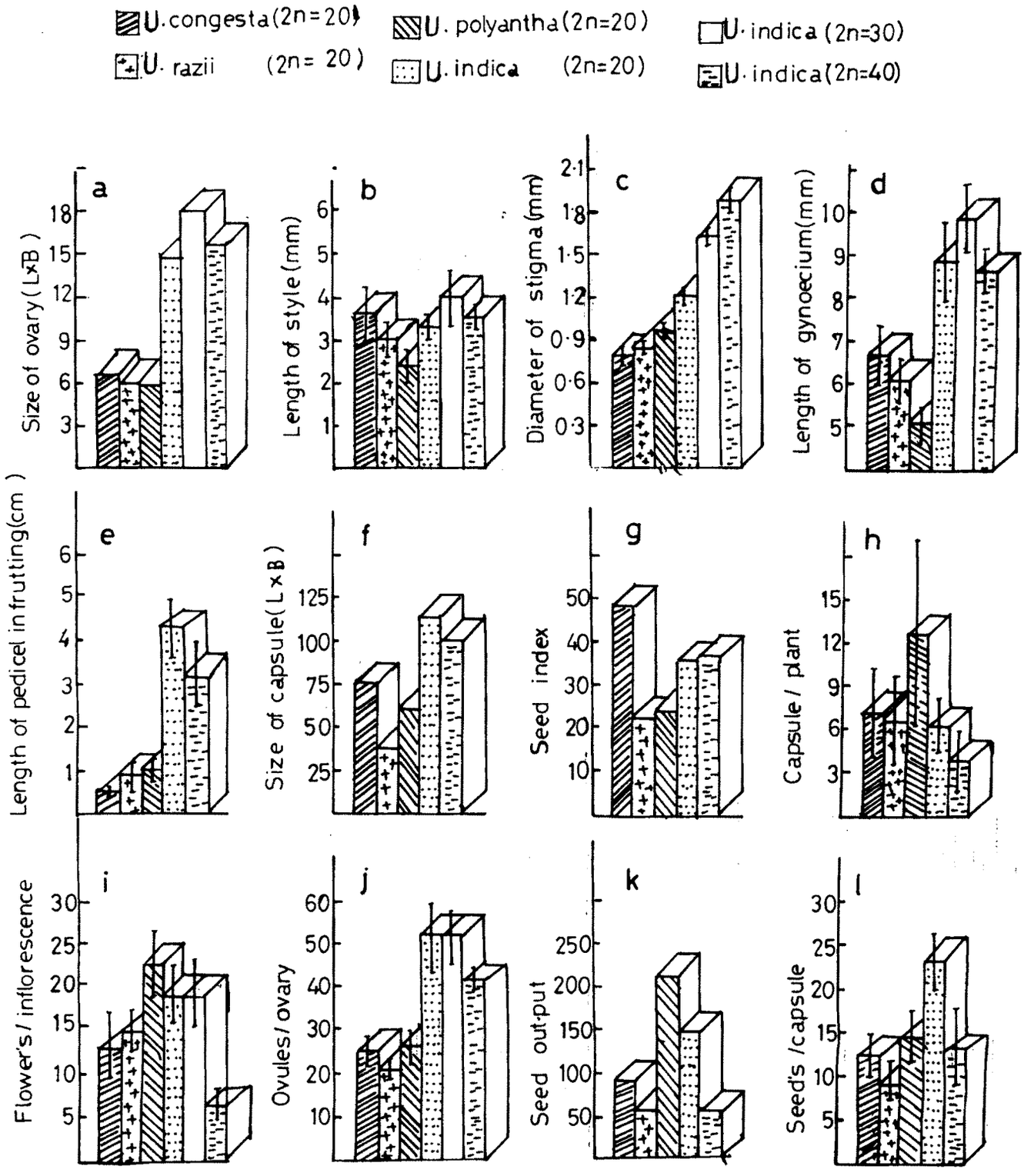


Fig-3- Reproductive, morphological character, seed out put of **Urginea** species

Table 4 : Showing comparative account of morphological characters of Urginea species.

Sr.No.	Morphological Character	Name and cytological status of the species					
		U.congesta 2n = 20	U.razii 2n = 20	U.polyantha 2n = 20	U.indica 2n = 20	U.indica 2n = 20	U.coromandeliana 2n = 20
1.	Diameter of bulb (cms)	3.8 ± 1.4	3.2 ± 0.9	3.9 ± 0.85	4.6 ± 0.95	5.7 ± 2.4	4.1 ± 1.08
2.	Height of the bulb (cm)	4.2 ± 1.2	4.2 ± 1.3	4.1 ± 0.90	5.7 ± 1.04	5.6 ± 1.5	4.7 ± 1.04
3.	Length of of bulb (cm)	1.9 ± 1.4	2.4 ± 1.2	1.7 ± 0.92	1.0 ± 0.69	0.9 ± 0.82	1.7 ± 1.3
4.	Total length of the plant	25.6 ± 5.3	21.8 ± 4.9	26.8 ± 6.7	37.3 ± 8.4	57.6 ± 9.8	25.4 ± 9.4
5.	Total leaves/plant	3.2 ± 0.4	4.9 ± 1.4	6.2 ± 2.2	8.9 ± 3.5	10. ± 3.2	7.6 ± 2.4
6.	Length of leaf	20.5 ± 5.2	15.8 ± 4.9	20.11± 5.8	26.9 ± 7.5	50.3 ± 7.5	20.2 ± 11.2
7.	Breadth of leaf	1.3 ± 0.25	0.32± 0.09	1.4 ± 0.57	3.10 ± 0.54	2.52 ± 0.89	1.3 ± 0.52
8.	Diameter of disc of bulb	0.99 ± 0.15	0.85 ± 0.16	1.6 ± 0.34	2.4 ± 0.4	2.2 ± 0.19	1.6 ± 0.39
9.	Roots/plant	3.9 ± 2.2	5.3 ± 1.9	9. ± 3.0	8.8 ± 4.5	7. ± 3.6	13.2 ± 5.8

Table 5 : Showing comparative account of reproductive characters of Urginea species

Sr.No.	Morp Characters	Name of the species					
		U.congesta 2n = 20	U.razii 2n = 20	U.polyantha 2n = 20	U.indica 2n = 20	U.indica 2n = 30	U.indica 2n = 40
1.	Height of the inflorescence(cm)	6.4 ± 1.02	15.7 ± 3.3	29.6 ± 8.2	95.5 ± 8.3	95.2 ± 16.2	42.5 ± 14.6
2.	Basal diameter of scape (mm)	2.3 ± 0.41	1.64 ± 0.26	2.8 ± 0.49	3.93 ± 0.12	4.64 ± 0.98	2.82 ± 0.61
3.	Pedicel length in flowering(cm)	0.36 ± 0.15	0.62 ± 0.22	0.83 ± 0.13	3.7 ± 0.84	3.54 ± 0.6	2.76 ± 0.6
4.	Diameter of the flower (cm)	1.57 ± 0.26	1.46 ± 0.2	1.42 ± 0.12	2.09 ± 0.25	2.25 ± 0.21	2.11 ± 0.2
5.	Length of outer petal(L) (mm)	7.2 ± 1.07	6.58 ± 0.81	6.41 ± 0.56	10.1 ± 2.02	10.8 ± 0.14	9.31 ± 0.75
6.	Breadth of outer petal(B)(mm)	3.3 ± 60.6	2.66 ± 0.35	2.95 ± 0.26	3.39 ± 0.3	4.4 ± 0.48	2.95 ± 0.29
7.	L x B of outer petal	23.76 ±	17.50	18.91	34.24	47.52	27.46
7.	Length of inner petal(L)(mm)	6.9 ± 1.0	6.3 ± 0.9	6.25 ± 0.62	9.57 ± 1.6	10.04 ± 0.11	8.96 ± 0.66
8.	Breadth of inner petal(B)(mm)	3.0 ± 0.6	2.04 ± 0.23	2.28 ± 0.31	2.76 ± 0.31	3.55 ± 0.40	2.33 ± 0.24
	L x B of inner petal	20.7	12.85	14.25	26.41	35.64	20.88
9.	Length of stamen (mm)	5.2 ± 0.8	5.2 ± 0.38	4.2 ± 0.52	7.69 ± 0.86	8.88 ± 0.145	7.4 ± 0.79
10.	Length of filament (mm)	3.5 ± 0.5	3.59 ± 0.36	2.9 ± 0.20	5.68 ± 0.46	5.71 ± 0.35	5.24 ± 0.54
11.	Length of anther (L) (mm)	3.5 ± 0.4	2.8 ± 0.46	2.62 ± 0.31	3.37 ± 0.39	3.73 ± 0.63	3.33 ± 0.46
12.	Breadth of anther (B)(mm)	1.4 ± 0.2	1.24 ± 0.63	1.33 ± 0.11	1.63 ± 0.13	1.59 ± 0.18	1.50 ± 0.035
13.	L x B of anther	4.9	3.47	3.485	5.493	5.931	4.995
13.	Length of Gynoecium (mm)	6.7 ± 0.7	6.09 ± 0.49	5.07 ± 0.42	8.86 ± 0.87	9.9 ± 0.82	8.66 ± 0.55
14.	Length of ovary (L) (mm)	3.2 ± 0.4	3.0 ± 0.24	3.06 ± 0.31	5.22 ± 0.67	5.9 ± 0.79	5.32 ± 0.35

Table 5 : Contd.

Sr.No.	Characters	Name of the species					
		D.congesta 2n = 20	D.ramii 2n = 20	D.polyantha 2n = 20	D.indica 2n = 20	D.indica 2n = 30	D.indica 2n = 40
16.	Length of style (mm)	3.6 ± 0.6	3.02 ± 0.4	2.42 ± 0.34	3.28 ± 0.35	3.98 ± 0.51	3.49 ± 0.33
17.	Diameter of the style (mm)	0.6 ± 0.1	0.52 ± 0.04	0.58 ± 0.04	0.79 ± 0.15	1.00 ± 0.00	1.05 ± 0.071
18.	Diameter of stigma (mm)	0.8 ± 0.2	0.85 ± 0.14	0.96 ± 0.15	1.21 ± 0.16	1.63 ± 0.17	1.86 ± 0.17
19.	Length of pedicelin fruiting (cm)	0.51 ± 0.12	0.91 ± 0.34	1.02 ± 0.27	4.31 ± 0.74	-	3.15 ± 0.65
20.	Length of fruit (L) (mm)	9.5 ± 2.1	7.86 ± 0.69	10.0 ± 1.26	18.8 ± 2.8	-	16.2 ± 0.27
21.	Breadth of fruti (B) (mm)	7.8 ± 1.0	4.86 ± 0.69	5.97 ± 0.67	6.1 ± 0.83	-	6.2 ± 0.1
	L x B of fruit	74.1	38.2	59.7	114.68	-	100.44
22.	Length of seed (mm)	7.7 ± 0.13	5.9 ± 0.57	5.8 ± 0.64	7.5 ± 1.56	-	7.56 ± 0.85
23.	Breadth of seed (mm)	6.2 ± 0.7	3.7 ± 0.34	5.05 ± 0.48	4.69 ± 0.53	-	4.78 ± 0.48
24.	Seed index (L x B)	48.05	21.83	35.15	35.15	-	36.1
25.	Flowers/inflorescence	12.9 ± 6.6	14.8 ± 5.24	23.2 ± 8.03	18.82 ± 6.5	21.5 ± 6.02	6.57 ± 2.8
26.	Ovules/Ovary	25.5 ± 3.3	20.6 ± 2.31	26.4 ± 3.78	52.5 ± 7.4	52.4 ± 7.8	42.4 ± 7.1
27.	Capsules/plant	7.1 ± 3.7	6.0 ± 3.38	14.61 ± 6.56	6.2 ± 1.93	-	3.97 ± 2.19
28.	Seeds/Capsule	12.6 ± 4.6	9.08 ± 4.46	14.55 ± 5.91	23.48 ± 6.13	-	13.71 ± 9.09
29.	Seed out put/plant	89.373	54.48	211.99	145.58	-	54.44

and their populations on morphological characters :

(1) Plants synanthus ... U.polyphylla

(1) Plants Hysteranthus

(2) Flowers remaining open in dry-time.

(3) Leaves per plant 3 ± 1, flat, spreading; on groupd; scape 6 ± 1 cm long; pedical length in flowering 4 ± 2 mm; capsule globose; seed index 48. U.congesta

(3) Leaves per plant 5 ± 2, narrowly linear, thick, fleshy, erect or ascending; scape length 16 ± 4 cm; pedicel length in flowering 6 ± 2 mm; capsules ellipsoid; seed index 22. U.razii

(3) Leaves per plant 6 ± 2, flat, spreading on ground; scape length 30±8 cm; pedicel length in flowering 8± 2 mm; capsules ellipsoid; seed index 23. U.polyantha

(2) Flowers remaining open in night time. U.indica

(4) Propagation through daughter bulbs; flowering but no fruit and seed setting, high pollen sterility (50%), distribution along coastal line.

Triploid population of U.indica

(4) Propagation through seeds, flowering fruiting and seed setting regular.

(5) Leaves flat, broadly linear, erect, 27±8 x 3±0.6 cm; scape length 96 ± 8 cm; pedicel length in flowering

4±1 cm; seed production per plant 145 ± 46; distributed along costal region (Mahmrashtra).

Diploid populations of U.indica

(5) Leaves flat, linear, erect or spreading on ground, 20 ± 11 x 1.3 ± 0.5 cm; scape length 43 ± 15 cm; pedicel length in flowering 3 ± 1 cm; seed production per plant 54 ± 30; distribution in fairly dry places in inland areas.

Tetraploid populations of U.indica.

2) Cytology :

For any type of work correct identification and cytological status of the species is important because in many species due to polyploidy same species possesses different number of chromosomes and show significant variations in morphology and therefore, somatic chromosome number of different species of Urginea under study was determined from growing root tips.

The chromosome numbers observed in different species of Urginea are depicted in Table 3 and shown in Photoplate-II (5-11.)

In U.congesta (Photoplate II-5), U.razii (Photoplate-II-6) and U.polyantha (Photoplate II-7) the somatic chromosome number was found to be 20. Populations of U.indica growing along sea-coast showed 2n = 20 (Photoplate II 8-9) and 2n = 30 (Photoplate II-10) somatic chromosome number, while those growing in eastern

Photoplate II (5-11) : Showing somatic chromosome number in Urginea species

5) U.congesta (2n = 20) x 2200

6) U.razii (2n = 20) x 2200

7) U.polyantha (2n = 20) x 2200

8) U.indica (2n = 20) x 2200

9) U.indica (2n = 20 + 3B) x 2200

10) U.indica (2n = 30) x 2200

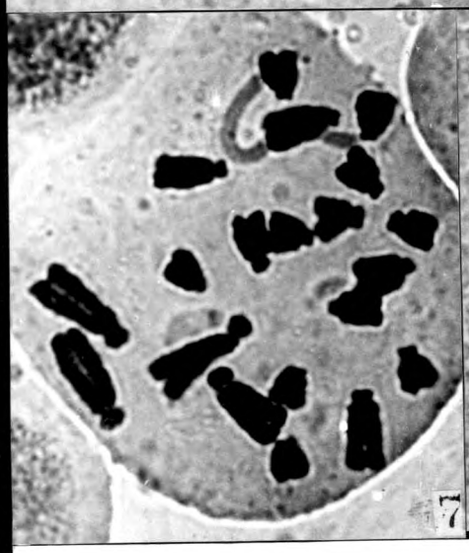
11) U.indica (2n = 40) x 2200

(B-Chro : B-Chromosomes).

PLATE II


5


6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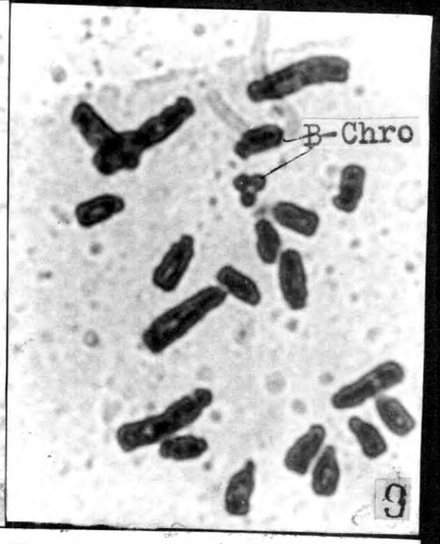

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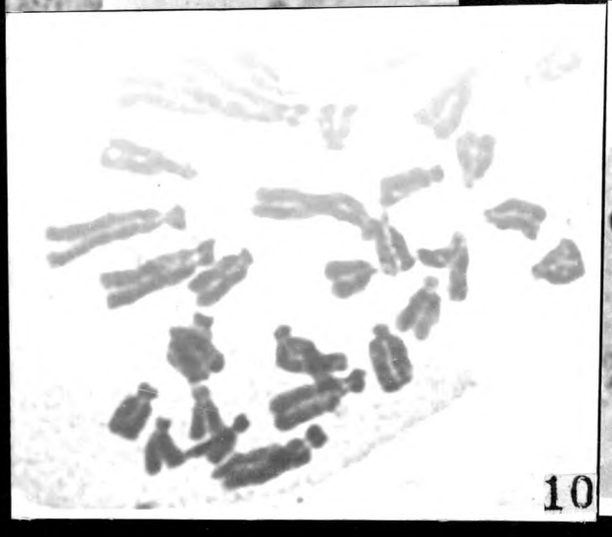
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parts of Maharashtra showed 40 (Photoplate II-11), somatic chromosome number. Some plants of U.polyantha from Shivaji University Campus showed 20 + 1 B chromosome. The diploid populations of U.indica from Ganapati-Pule showed 3 β (Photoplate II-9) chromosomes. The chromosomes in general are telocentric or subtelocentric in all Indian species (Photoplate II 7-11).

3) Palynology :

The pollen grains of different Indian species of Urginea are elliptical in shape with pointed polar ends (Photoplate III 12-13). The pollen grains of different species showed variations in size, ornamentation, pollen size frequency classes and pollen fertility.

1. U.congesta (Table 6 &7, Fig.4; Photoplate III-14 and Photoplate-IV 20-21).

Unhydrated pollen grains are elliptic in shape with pointed polar ends ranging in size from 62-76 x 22-32 µm. An average size range of unhydrated pollen grains was found to be 71 x 27 µm. Hydrated pollen grains are spheroidal (Photoplate III-14) in shape ranging in size from 42-91 x 16-83 um averaging to 65 x 62 µm which represented dominant class of pollen grains. Acetolysed pollen grains range in size from 41-80 x 24-50 µm averaging to 62 x 44 µm. The pollen grains are uniform in size with very little variations. The pollen grains are monocolpate with microreticulate ornamentation (Photoplate IV-21).

The dominant class of hydrated pollen ranged in size from 56-66 µm (Table 7, Fig.4 f). Pollen grains less than 50 µm in diameter were mostly sterile. Fertile pollen grains showed elongated generative cell and remains of degenerating vegetative nucleus (Photoplate III-14 and Photoplate IV-20). The pollen grains are usually shed in two celled condition but rarely 3-celled pollen grains were observed. The pollen fertility (Table 7; Fig.4 d) ranged from 94 to 98% and average pollen fertility was as high as 96 percent.

2. U.razii (Table 6 & 7, Fig.4, Photoplate III-5 and Photoplate-IV 22-23). :

Unhydrated pollen grains are elliptic in shape with pointed ends, ranging in size from 68-84 x 24-35 µm averaging to 75 x 30 µm. Hydrated pollen grains are spheroidal (photoplate III-15, Photoplate-IV 22) in shape ranging in size from 33-91 x 16-91 µm. Average size of hydrated pollen grains was found to be 73-69 µm. Acetolyzed pollen grains ranged in size from 46-81 x 32-51 µm averaging to 63 x 41 µm. The pollen grains are monocolpate with micro-reticulate ornamentation (Photoplate IV-23).

The dominant class of hydrated pollen ranged in size from 69-73 µm (Table 7, Fig.4 e) and the pollen grains less than 50 µm in diameter were found to be sterile. Fertile pollen grains showed microreticulate ornamentation, usually concave elongated generative cell and remains of degenerating vegetative

nucleus (Photoplate III-15 and Photoplate IV-22). The pollen grains at the time of their dispersal are in 2-celled condition. The pollen fertility ranged from 92 to 95% averaging to 93 per cent (Table 7, Fig.4 d).

3. U.polyantha (Table 6 & 7, Fig.4; Photoplate-III 16 and Photoplate IV 24-25).

Unhydrated pollen grains are elliptic in shape with pointed polar ends ranging in size from 65-81 x 24-32 µm averaging to 73 x 28 µm. Hydrated pollen grains are spheroidal (Photoplate III 16 and Photoplate IV-24) in shape ranging in size from 33-91 x 17-83 µm averaging to 68 x 64 µm. The pollen grains of 68 x 64 µm in size represent the dominant class of pollens. Acetolyzed pollen grains ranged in size from 46-84 x 41-57 µm averaging to 62 x 44 µm. The pollen grains are monocolpate with reticulate ornamentation (Photoplate IV 24-25).

The dominant class of hydrated pollen range from 58-66 µm (Table 7, Fig.4 g) and pollen grains less than 50 µm in diameter were usually sterile. Fertile pollen grain show usually a curved elongated generative cell and remains of degenerating vegetative nucleus (Photoplate III-16 and Photoplate IV-24). Pollen grains are shed in two celled condition. Pollen fertility range from 90-98% (Table 7, Fig.4 d) averaging to 94 per cent.

4. U.indica (2n = 20) (Table 6 & 7, Fig.4, Photoplate III-17) :

Unhydrated pollen grains are elliptic in shape with pointed polar ends (Photoplate III 12-13) ranging in size from 70-86 x 30-39 µm averaging to 82 x 32 µm. Hydrated pollen grains are more or less spheroidal (Photoplate III-17 and Photoplate IV-26) in shape ranging in size from 42-100 x 17-100 µm averaging to 80 x 78 µm. Acetolyzed pollen grains range in size from 62-108 x 46-65 µm averaging to 88 x 55 µm. Pollen grains are comparatively large, coarse-reticulate (Photoplate IV.27° uniform in size and monocolpate.

The dominant class of hydrated pollen grains range in size from 74-80 µm (Table 7, Fig.4-h). The pollen grains less than 60 µm in diameter were usually found to be sterile. Fertile pollen grains show a concave elongated generative cell and remains of degenerating vegetative nucleus (Photoplate III-17). The pollen grains are shed in two celled condition. The pollen fertility range from 90-97% averaging to 93 per cent (Table 7, Fig.4-d).

5. U.indica (2n = 30) (Table 6 & 7, Fig.4; Photoplate III-18, Photoplate IV 28-29).

Unhydrated pollen grains are elliptic in shape with pointed polar ends ranging in size from 30-95 x 11-41 µm averaging to 65 x 30 µm. The pollen grains show great variation

in size, shape and fertility. Hydrated pollen grains are triangular, concave, elliptic or spheroidal (Photoplate III-18) in shape ranging in size from 42-125 x 17-125 µm averaging to 66-56 µm. Acetolyzed pollen grains ranged in size from 49-108 x 22-70 µm averaging to 71-41 µm. The pollen grains are monocolpate with fine to coarse-reticulate (Photoplate IV 28-29) ornamentation.

There was no any dominant class of pollen grains and showed 2-3 peaks of pollen size frequency classes (Table 7, Fig.4-1). About 30% of pollen grains (largest class) ranged in size from 40-60 µm and were found to be mostly sterile. In different populations the pollen fertility varied from 32-51 (Table 7) percent. Average pollen fertility was found to be 41% (Fig.4-d) which positively indicate unstable nature of populations and could be used to assess the cytological status of the species. Fertile pollen grains showed curved generative cell and remains of degenerating vegetative nucleus (Photoplate III-18). Fertile pollen grains are shed in two celled condition.

6. U.indica (2n = 40) :

Unhydrated pollen grains are elliptic in shape with pointed polar ends ranging in size from 42-90 x 17-40 µm averaging to 87 x 35 µm. Hydrated pollen grains are spheroidal (Photoplate III-19, Photoplate IV-30), in shape ranging in size from 42-100 x 25-91 µm averaging to 83 x 79 µm. Most of the

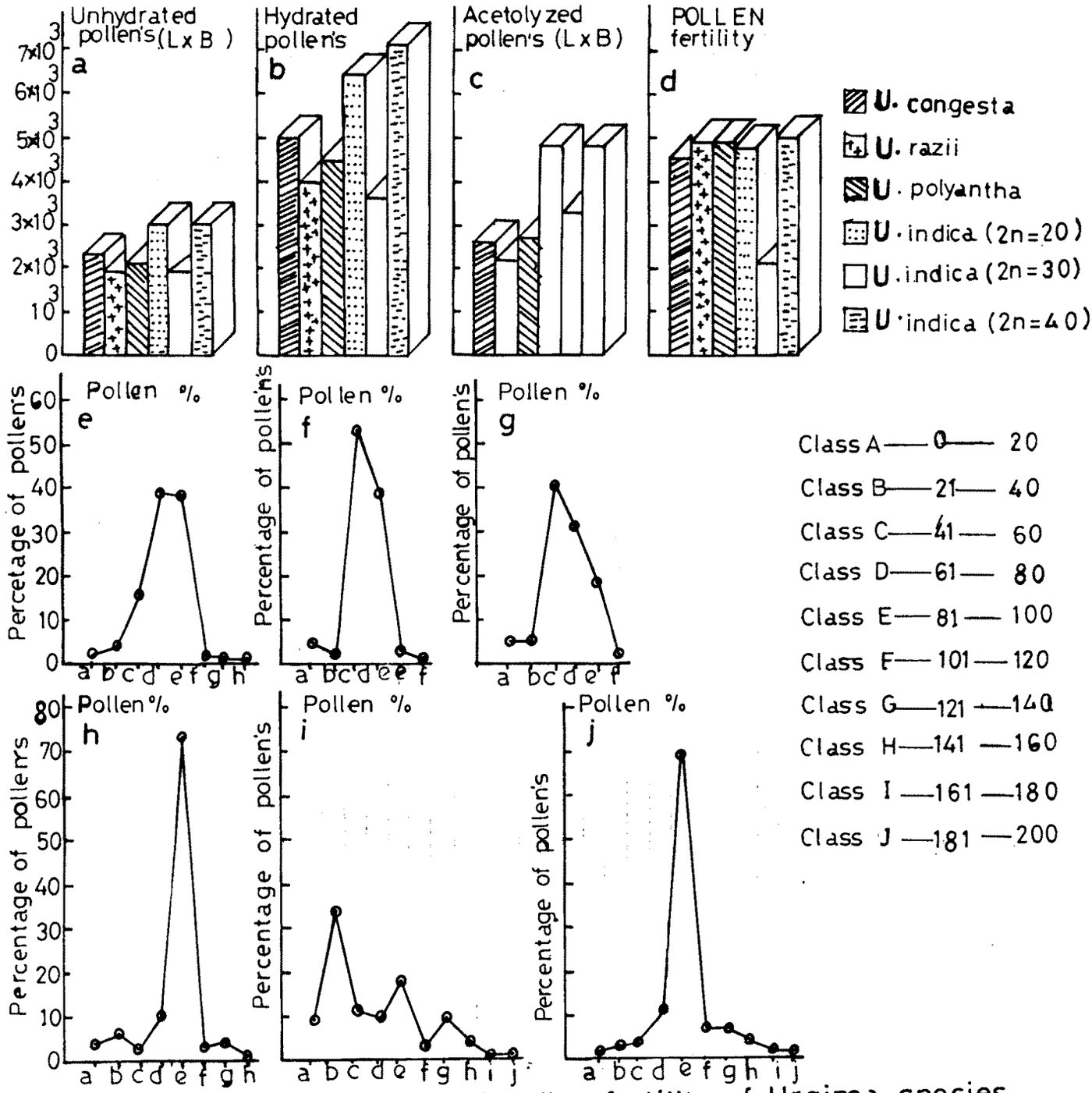


Fig-4 - Pollen morphology and pollen fertility of Urginea species

Table 6 : Showing comparative account of pollen characters of Urginea species

Sr. No.	Palynological characters	Name of the species					
		U.congesta	U.razii	U.polyantha	U.indica (2n = 20)	U.indica (2n=30)	U.indica (2n=40)
1.	Cytological status	2n = 20	2n = 20	2n = 20	2n = 20	2n = 30	2n = 40
2.	Ornamentation	Fine reticulate	Fine reticulate	Reticulate	Coarse reticulate	Coarse reticulate	Coarse reticulate
3.	Size of unhydrated pollens						
	i) Range (μ)	62 x 22 - 76 x 32	68 x 24 - 84 x 35	65 x 24 - 81 x 32	70 x 30 - 86 x 39	30 x 11 - 95 x 41	42 x 17 - 90 x 40
	ii) Average (μ)	71 x 27	75 x 30	73 x 28	82 x 32	65 x 30	87 x 35
4.	Size of hydrated pollens						
	i) Range (μ)	42 x 16 - 91 x 83	33 x 16 - 91 x 91	33 x 17 - 91 x 83	42 x 17 -100 x 100	42 x 17 -125 x 125	42 x 25 -100 x 91
	ii) Average (μ)	65 x 62	73 x 69	68 x 64	80 x 78	66 x 56	83 x 79
5.	Size of acetolysed pollens						
	i) Range (μ)	41 x 24 - 80 x 50	46 x 32 - 81 x 51	46 x 51 - 84 x 57	82 x 46 -108 x 65	49 x 22 -108 x 70	81 x 35 -113 x 68
	ii) Average (μ)	56 x 40	63 x 41	62 x 44	88 x 55	71 x 41	96 x 50
6.	Pollen condition at time of shedding	Usually 2 celled	2 celled	2 celled	2 celled	2 celled	2 celled

Table 7 : Showing comparative account of size frequency classes and pollen fertility of Urginea species.

Size of classes Length x Breadth of pollen (occular division)	Name of the species					
	U.congesta (2n = 20)	U.razii (2n = 20)	U.polyantha (2n = 20)	U.indica (2n = 20)	U.indica (2n = 30)	U.indica (2n = 40)
A 1 - 20	4.21	1.57	4.80	3.46	8.95	0.83
B 21 - 40	1.76	3.88	5.27	4.75	34.46	2.49
C 41 - 60	53.26	16.52	40.39	3.37	10.75	4.53
D 61 - 80	39.70	39.70	31.26	10.81	10.30	11.47
E 81 - 100	0.98	37.93	18.17	71.97	18.13	68.82
F 101 - 120	0.098	0.66	0.094	2.42	3.54	7.40
G 121 - 140	-	0.08	-	3.11	8.95	4.39
H 141 - 160	-	-	-	0.86	3.83	0.092
I 161 - 180	-	-	-	-	0.75	-
J 181 - 200	-	-	-	-	0.225	-
K 201 - 220	-	-	-	-	0.075	-

Table 7 : (Contd.....)

Size of classes Length x Breadth of pollen (Occular division)	Name of the species					
	U.congesta (2n = 20)	U.razii (2n = 20)	U.polyantha (2n = 20)	U.indica (2n = 20)	U.indica (2n = 30)	U.indica (2n = 40)
Pollen fertility	Singhapur = 98(1987)	Diva = 92 (1981)	Kolhapur = 98(1987)	Nagneswari =97(1987)	Alibag =81(1987)	Singhapur = 83(1987)
% of fertile pollen	Karthikmand = 95(1988)	Diva = 95 (1988)	Kolhapur =96(1988)	Araunda =90(1985)	Alibag =80(1988)	Kagal = 98 (1987)
	Singhapur =94(1988)		Poona =90 (1986)	Nagneswari =92(1988)	Goa =46 (1987)	Kagal =98 (1987)
					Goa =36 (1988)	Piliv =97 (1987)
					Ganapatipule =38	
					Araunda =35 (1985)	
Average	93	96	94	93	41	93

Photoplate-III (12-19) : Showing pollen characters and Pollen fertility of *Urginea* sps.

Unhydrated pollens of *U.indica* (2n = 20)

12) with white background x 120

13) with black background x 120

Hydrated pollens of

14) *U.congesta* x 120

15) *U.razii* x 120

16) *U.polyantha* x 120

17) *U.indica* (2n = 20) x 120

18) *U.indica* (2n = 30) x 120

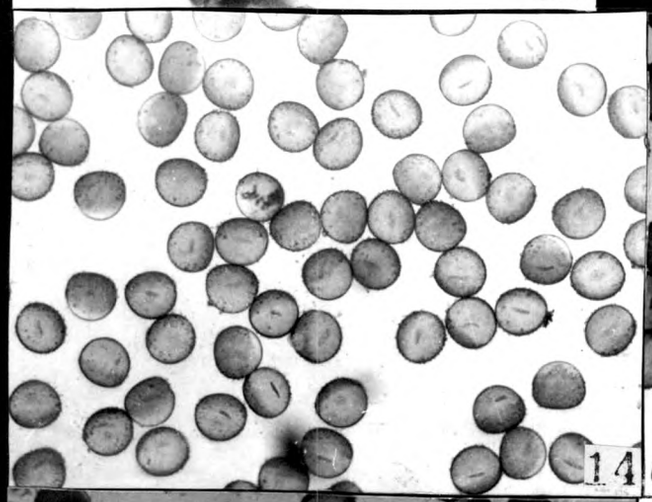
19) *U.indica* (2n = 40) x 120

(GC : Generative Cell; FP : fertile pollens, SP : Sterile pollens)

PLATE III


12


13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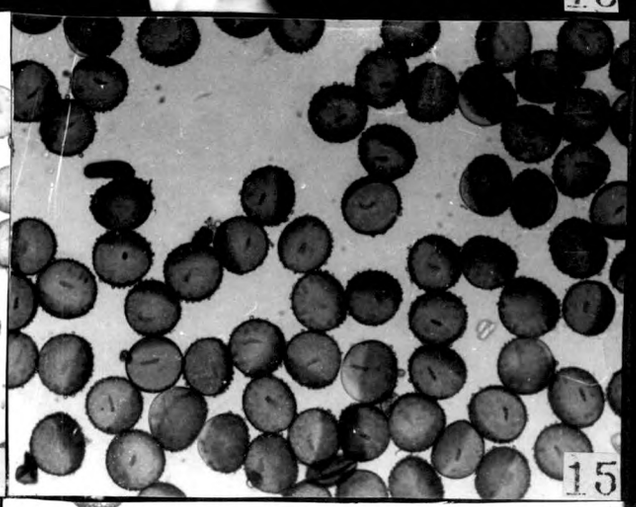
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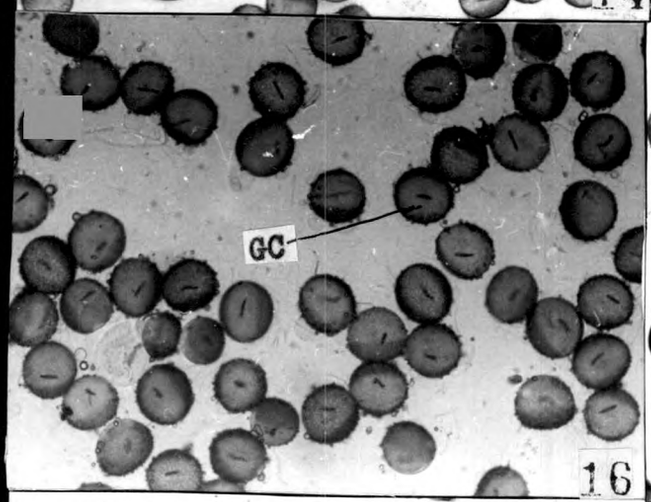

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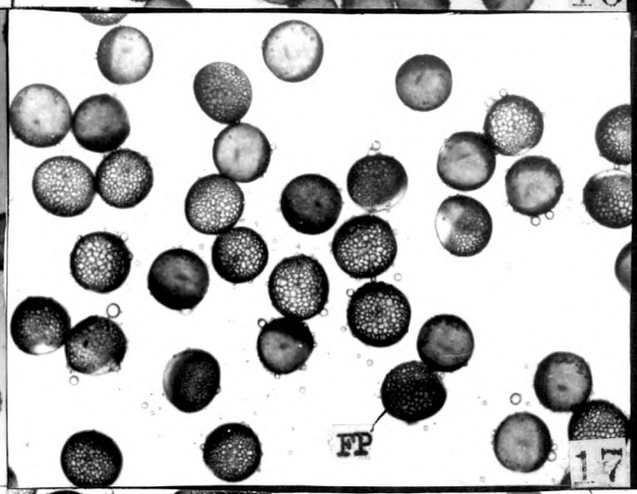

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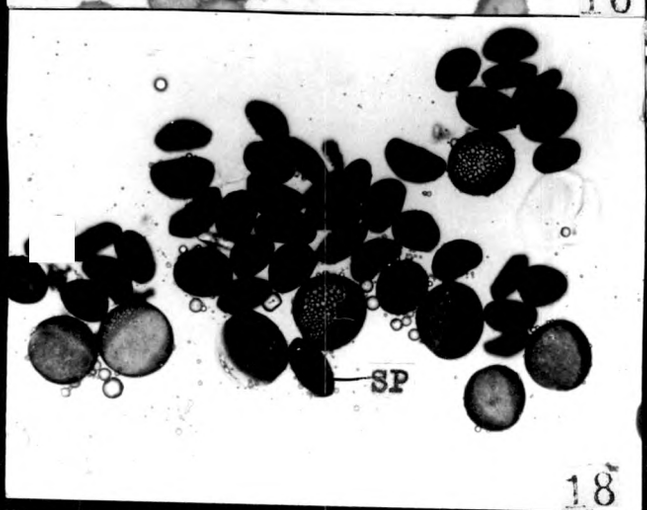

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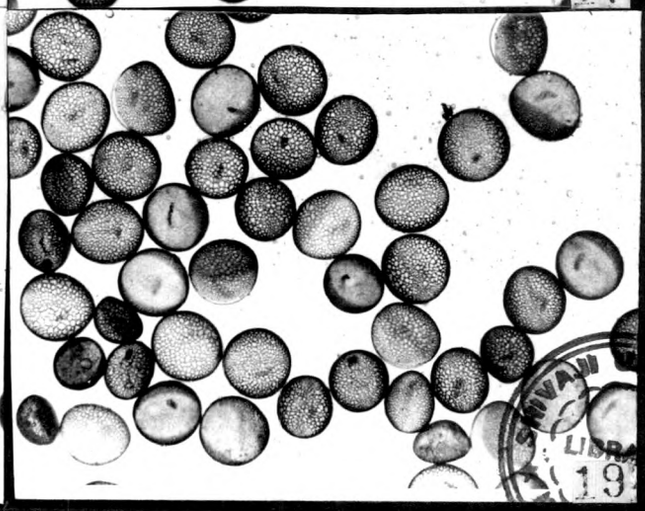
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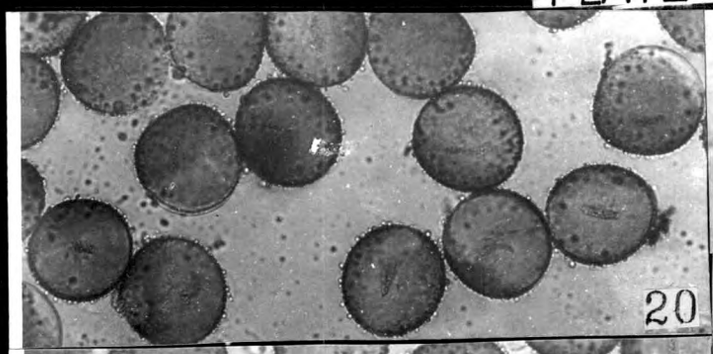
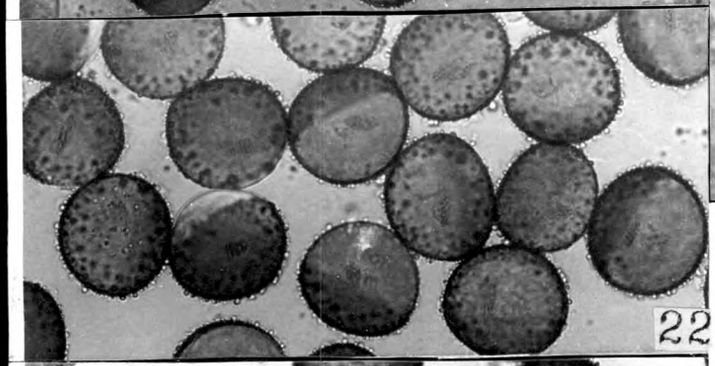
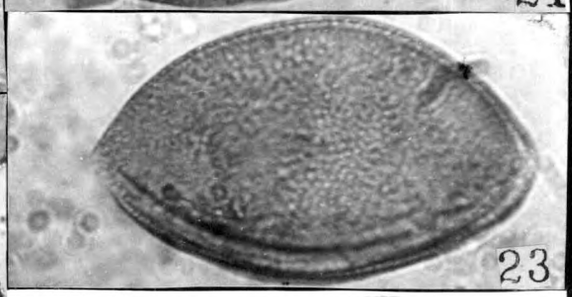
Photoplate IV (20-31) : Showing pollen characters and wall ornamentation of Urginea species.

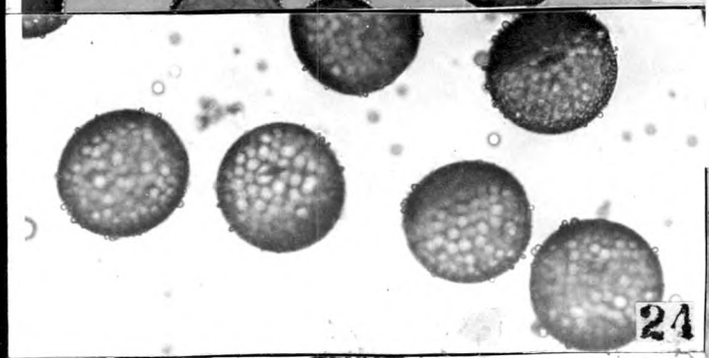
Hydrated pollens of :	Acetolyzed pollens of :
20) U.congesta x 240	21) U.congesta x 875
22) U.razii x 240	23) U.razii x 875
24) U.polyantha x 240	25) U.polyantha x 875
26) U.indica (2n=20)x240	27) U.indica(2n=20)x875
28) U.indica (2n=30)x240	29) U.indica(2n=30)x875
30) U.indica (2n=40)x240	31) U.indica(2n=40)x875

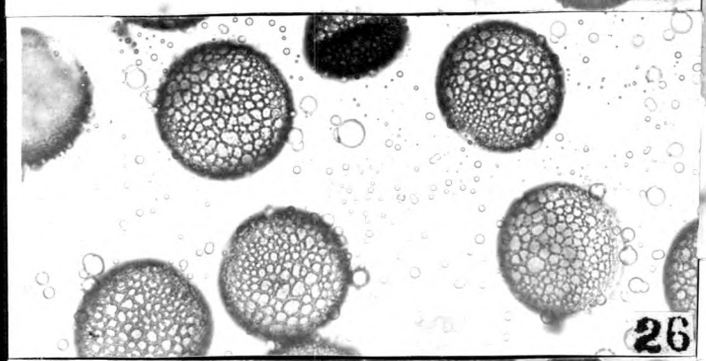
PLATE IV

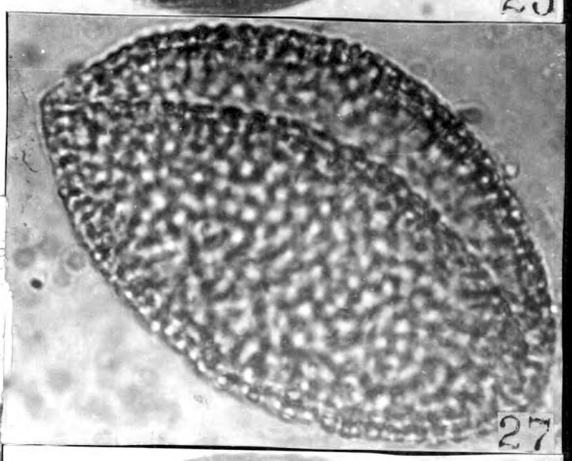


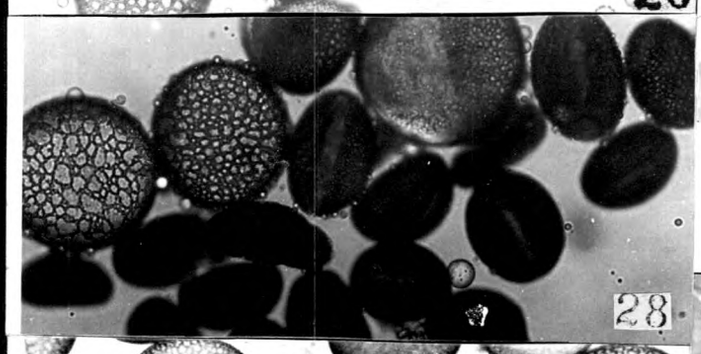


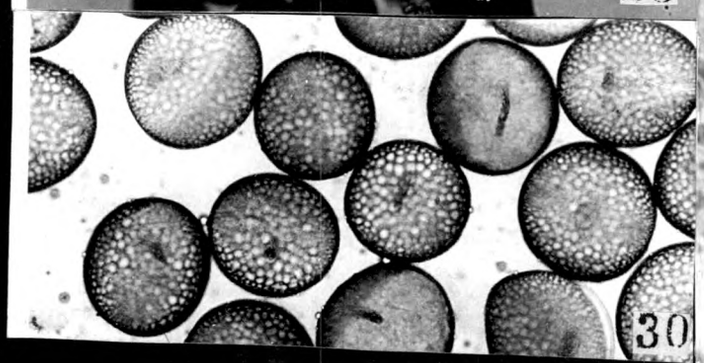


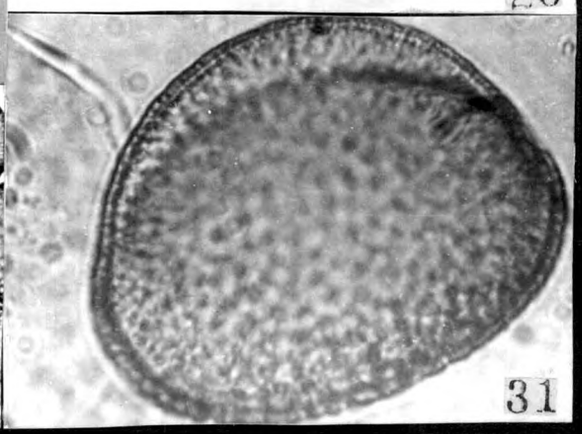












pollen grains are uniform in size. Acetolyzed pollen grains range in size from 81-113 x 35-68 µm averaging to 96 x 50 µm. The pollen grains are monocolpate with coarse reticulate ornamentation.

The dominant pollen class ranged in size from 74-86 µm (Table 7, Fig.4, Photoplate IV 30-31) and the pollen grains less than 60 µm in diameter were found to be sterile. Fertile pollen grains show more or less concave elongated generative cell and remains of degenerating vegetative nucleus, (Photoplate III-19, Photoplate IV-30). Pollen grains are shed in two celled condition. The pollen fertility (Table 7, Fig.4 d) varied from 83-97 percent averaging to 93%. High pollen fertility indicates the stable nature of the species.

On the basis of pollen morphology, Indian species of Urginea can be grouped into two distinct groups.

a) Pollen grains ranging in size from 55-70 µm with fine reticulate ornamentation - U.congesta, U.razii and U.polyantha.

b) Pollen grains ranging is size from 75 — 80 µm with coarse reticulate ornamentation - U.indica.

4) Anatomy :

a) Scape anatomy (Table 8, Text Fig.I, Fig.5 a-g; Photoplate V, Photoplate VI) :

All the species studied have unbranched cylindrical

scapes. The length and basal diameter of scapes varied greatly in different species and could be used for identification of the species. Detailed description of scape anatomy is as follows :

1. U.congesta (Table 8, Fig.5-g, Text Fig.1-1; Photoplate V-32-34).

It has shortest scape (Fig.1 a) length (as compared to other Indian species) averaging to 6.4 ± 1.02 cm with basal diameter of 2.27 ± 0.42 mm. The scape is circular in outline in lower region and show inconspicuous ridges and furrows in upper portion. In tangential section of scape (Text Fig.1), (Photoplate V 32-35), four distinct layers can be distinguished viz. single layered epidermis, 2-3 layered parenchymatous hypodermis, 3-6 layered sclerenchymatous cortex and ground parenchyma with vascular bundles. Single layered epidermis has a thick waxy coating on outer wall and possesses stomata. The cells of epidermis are rectangular in shape and varied in length from 100-420 µm averaging to 287 ± 93 µm. In transverse section the epidermal cells are radially elongated ranging in size from 21-26 x 11-18 µm and averaging to 23.4 ± 1.94 x 15.58 ± 2.91 µm. Hypodermis is 2-3 layered made up of rectangular vertically elongated parenchymatous cells, which are circular in outline in transverse section and contain chloroplast and bluish-red pigments. Hypodermis varied in thickness from 40-90 µm averaging to 82.8 ± 14.5 µm. The cortex is 3-6 layered and varied in thickness from 90-170 µm averaging to

142.5 ± 8.5 µm. In transverse section, the cells of cortex are isodiametric to angular in outline with thick walls enclosing intercellular spaces at angles. The sclerenchymatous fibre cells (Photoplate V-34) are vertically elongated and varied in size from 238-798 x 14-35 µm averaging to 487 ± 154 x 25 ± 4.1 µm. Ground parenchyma is made up of vertically elongated, rectangular cells which are isodiametric in transverse section and enclosing intercellular spaces. In ground parenchyma there are 5-6 large central vascular bundles surrounded by 12-14 small peripheral vascular bundles. The central large vascular bundles varied in size from 135-300 x 105-165 µm. The metaxylems are usually arranged in 2-3 radial rows and have spiral thickenings on their walls.

2. U.razii (Table 8, Fig.5 a-g, Text Fig.1-2, Photoplate V 35-37).

The average length of scape was 15.7 ± 3.3 cm and basal diameter 1.64 ± 0.26 mm. The scape is circular in outline in lower region while in upper region it shows ridges. In tangential section of scape (Text Fig.1-2, Photoplate V 85-86) four distinct layers can be distinguished as single layered epidermis, 2-3 layered parenchymatous hypodermis, 3-5 layered sclerenchymatous cortex and ground parenchyma with vascular bundles. Single layered epidermis has a thick waxy coating on outer wall and possesses stomatas. The cells of epidermis are rectangular in shape and varied in length from 56-264 µm averaging to 170 ± 55 µm.

In transverse section the epidermal cells varied in size from 16-24 x 16-32 µm averaging to 17.4 ± 1.4 x 11.98 ± 1.8 µm and are some what elongated. Hypodermis is 2-3 layered made up of rectangular parenchymatous cells which are circular in outline in transverse section and contain chloroplast and some pigments. The sclerenchymatous cortex is 3-5 layered and varied in thickness from 96-160 µm averaging to 101 ± 16 µm. In transverse section the cells of cortex are isodiametric to angular in shape, thick walled and have intercellular spaces. The fibre cells (Photoplate V-37) are vertically elongated and varied in size from 434-1050 x 14-28 µm averaging to 770 ± 165 x 24.8 ± 5.2 µm. Ground parenchyma is made up of vertically elongated rectangular cells which are isodiametric in transverse section and encloses intercellular spaces. In ground parenchyma there are 4-5 large central vascular bundles around which there are 9-13 small peripheral vascular bundles. Inner central vascular bundles ranged in size from 160-200 x 80-96 µm averaging to 180.11 ± 20.02 x 90.8 ± 23.3 µm. The metaxylems are usually arranged in single radial row and have spiral thickening on their walls.

3. U.polyantha (Table 8, Fig.5 a-g, Text Fig.1-3, Photoplate V 38-40) :

The scape length averaged to 29.6 ± 8.2 cm with basal diameter of 2.8 ± 0.49 mm. In basal region the scape is circular in outline and becomes slightly wavy in upper portion. In tangential section of scape (Text Fig.1-3, Photoplate V 38-39)

usual four layers can be distinguished as described in above species. Outermost layer called epidermis has a thick waxy coating on its outer surface and possesses stomata. The cells of epidermis are vertically elongated, rectangular which varied in length from 100-320 µm averaging to 198 ± 68 µm. In transverse section the epidermal cells ranged in size from 14-18 x 11-22 µm averaging to 15.1 ± 1.58 x 16.4 ± 4.1 µm and are almost circular in outline. Hypodermis is 2-3 layered made up of small vertically elongated rectangular cells which are circular in outline in transverse section and contain chloroplasts and some pigments. It varied in thickness from 32-72 µm averaging to 59.8 ± 5.4 µm. Cortex is made up of 3-5 layers of sclerenchymatous cells which varied in thickness from 95-172 µm averaging to 118.1 ± 8.6 µm. In transverse section the sclerenchymatous cells of outer cortex are isodiametric to angular in outline, thick-walled and have intercellular spaces at angles. The sclerenchymatous cells are vertically elongated (Photoplate V 40) which varied in size from 341-992 µm x 15-31 µm averaging to 768 ± 182 x 25.6 ± 10.9 µm. The ground parenchyma is made up of vertically elongated cells which enclose intercellular spaces. In ground parenchyma there are 7-8 large central vascular bundles around which there are 16-21 small peripheral vascular bundles. The central vascular bundles varied in size from 96-240 x 40-140 µm averaging to 231 ± 55.4 x 70.8 ± 7.7 µm. Metaxylem are usually arranged in 1-2 rows and have spiral thickenings on their walls.

4. U.indica (2n = 20) (Table 8, Fig.5 a-g, Text Fig.1-4, Photoplate VI 41-43) :

It showed longest scape among the species studied. The length of scape averaged to 93.5 ± 8.3 cm with basal diameter of 3.93 ± 0.12 mm. The scape is circular in outline in lower portion and shows small grooves in upper portion. In tangential section of scape (Text Fig.1-4, Photoplate VI 41-42) four distinct layers can be distinguished. The outermost epidermis is single layered made up of vertically elongated rectangular cells and cells of epidermis varied in length from 200-430 µm averaging to 323.6 ± 100 µm and possesses stomata. The cells of epidermis in transverse section ranged in size from 11-14 x 14-18 µm averaging to 13 ± 2 x 17 ± 2 µm and are almost circular in outline. They are covered with thick waxy coating on outer surface. Below epidermis there is 3-4 layered hypodermis made up of vertically elongated parenchymatous cells which enclose intercellular spaces and contain chloroplasts and pigments. The cells of hypodermis in transverse section are circular in outline. Hypodermis varied in thickness from 48-80 µm averaging to 54 ± 9 µm. Thickest sclerenchymatous cortex was observed in this species. It is 12-18 layered and varied in thickness from 224-320 µm averaging to 274.96 ± 16.59 µm. The sclerenchymatous fibres (Photoplate VI-43) varied in length from 682-1705 x 15-31 µm averaging to 1344 ± 345 x 22.4 ± 8.3 µm. Inside the cortex there is a ground tissue made up of vertically elongated thin

walled parenchymatous cells which enclose intercellular spaces and are isodiametric in shape in transverse section. In ground parenchyma there are 6-7 large central vascular bundles surrounded by 24-38 small peripheral vascular bundles. The large central vascular bundles ranged in size from 176-360 x 48-96 µm averaging to 250.9 ± 43.1 µm. Metaxyleme are usually arranged in 1-2 rows and have spiral thickenings on their walls.

5. U.indica (2n = 30) (Table 8, Fig.5 a-g, Text Fig.1-4, Photoplate VI 44-46) :

The length of scape averaged to 95.2 ± 16.2 cm with basal diameter 4.64 ± 0.98 mm. The scape is circular in outline in lower portion while it shows small grooves in upper portion. In tangential section of scape (Text Fig.1-5, Photoplate VI 44-45) four distinct layered can be observed viz. epidermis, hypodermis, sclerenchymatous cortex and inner most ground parenchyma. The outermost epidermis is single layered made up of vertically elongated rectangular cells which varied in length from 650-1000 µm averaging to 825 ± 134 µm and possessed stomata. The cells of epidermis in transverse section ranged in size from 11-18 x 14-18 µm averaging to 15.1 ± 2.98 x 17.28 ± 1.58 µm and are almost circular in outline. They are covered with thick waxy coating on outer surface. The hypodermis which is 2-4 layered made up of thin walled vertically elongated parenchymatous cells which enclose intercellular spaces and contain chloroplasts

and pigments. Hypodermis varied in thickness from 46-90 µm averaging to 53.3 ± 4.68 µm. Cortex is made up of thickwalled sclerenchymatous fibre cells. It is 9-16 layered and varied in thickness from 180-225 µm averaging 200.92 ± 20.16 µm. The sclerenchymatous fibres (Photoplate VI-46) varied in size from 651-1364 x 15-38 µm averaging to 1184 ± 415 x 28.8 ± 6.4 µm. Sclerenchymatous cortex surrounds the ground parenchyma. Ground parenchyma is made up of vertically elongated thin-walled parenchymatous cells. The cells of ground parenchyma encloses intercellular spaces and are isodiametric in outline. In ground parenchyma there are 7-10 large central vascular bundles surrounded by 26-41 small peripheral vascular bundles. The size of the central large vascular bundles varied from 225-330 x 120-135 µm averaging to 289.5 ± 38.5 x 129.3 ± 8.3 µm. Metaxylems are usually 2-4 in number and are arranged in single row. Metaxylems possess spiral thickenings on their walls.

6. U.indica (2n = 40) (Table 8, Fig.5 a-g, Text Fig.1-6, Photoplate VI 47-49) :

The length of scape averaged to 45.2 ± 14.6 cm with basal diameter of 2.81 ± 0.2 mm. The scape is circular in outline in lower portion and shows small grooves in upper portion. In tangential section of scape (Text Fig.1-6, Photoplate VI 47-48) four distinct layers can be observed. The outermost single layered epidermis is made up of vertically elongated, rectangular

cells which varied in length from 500-1000 µm averaging to 711 ± 183 µm and possessed stomata. The cells of epidermis in transverse section ranged in size from 29-40 x 18-29 µm averaging to 32.4 ± 5.01 x 22.3 ± 4.7 µm and are almost circular in outline. The cells of epidermis are covered with thick waxy coating on outer surface. Hypodermis is 2-4 layered made up of thin walled vertically elongated parenchymatous cells which enclose intercellular spaces and contain chloroplasts and some pigments. Hypodermis varied in thickness from 48-94 µm averaging to 58.3 ± 14.7 µm. Below hypodermis there is a 6-8 layered sclerenchymatous cortex made up of thick walled fibre cells. Cortex varied in thickness from 120-225 µm averaging to 154.16 ± 9.0 µm. The sclerenchymatous fibres (Photoplate VI-49) varied in size from 868-2294 x 22-40 µm averaging to 2080 ± 370 x 29 ± 6.7 µm. The ground tissue is made up of vertically elongated, thin-walled parenchymatous cells which enclose intercellular spaces and are isodiametric in outline in transverse section. In ground parenchyma there are 6-8 large central vascular bundles which are surrounded by 24-30 small peripheral vascular bundles. The size of vascular bundles ranged from 235-285 x 60-120 µm averaging to 225 ± 35 x 93 ± 28 µm. Metaxylem per vascular bundle ranged from 3-10 usually arranged in two rows. They have spiral thickening on their walls.

Based on anatomy of scape following key to the Indian species of Urginea is suggested.

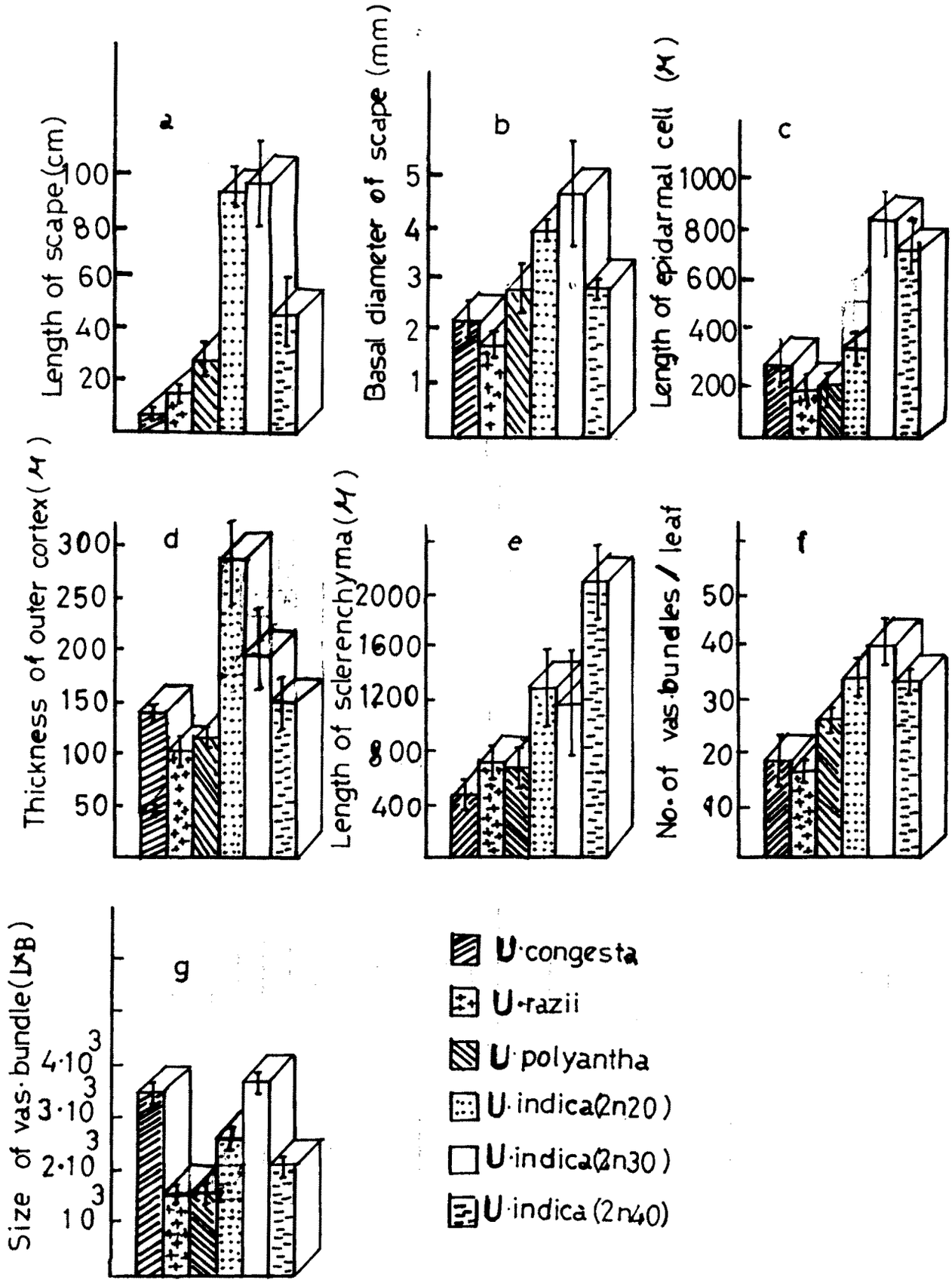


Fig-5-Scape anatomy of Urginea species

Table 8 : Showing comparative account of scape anatomy of Urginea species.

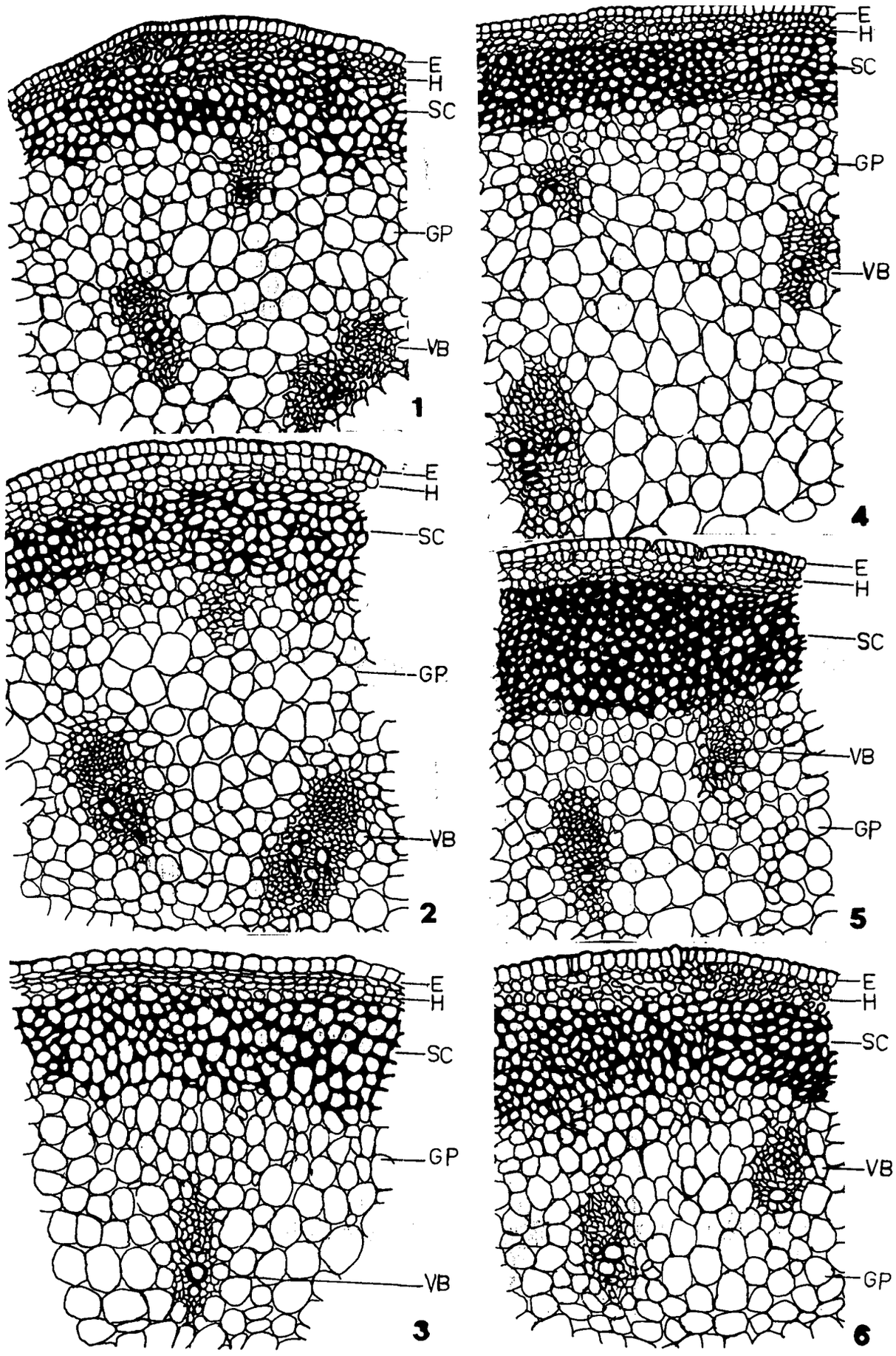
No.	Character	Name of the species					
		U.congesta	U.razii	U.polyantha	U.indica (2n = 20)	U.indica (2n = 30)	U.indica (2n = 40)
1.	Length of scape (cm)	6.4 ± 1.02	15.7 ± 3.3	29.6 ± 8.2	93.5 ± 8.3	95.2 ± 16.2	45.2 ± 14.6
2.	Diameter of scape (mm)	2.27 ± 0.41	1.64 ± 0.26	2.8 ± 0.49	3.93 ± 0.115	4.64 ± 0.98	2.81 ± 0.20
3.	Length of epidermal cell (um)	287 ± 93.2	170 ± 55.01	198 ± 68.6	323 ± 100	825 ± 133.8	711 + ± 182.
4.	Tangential diameter of epidermal cell(um)	23.4 ± 1.94	17.4 ± 1.44	15.12 ± 1.58	12.96 ± 1.94	15.12 ± 2.98	32.4 ± 5.07
5.	Radial diameter of epidermal cell (um)	15.58 ± 2.91	11.98 ± 1.83	16.36 ± 4.1	16.56 ± 1.94	17.28 ± 1.58	22.32 ± 468
6.	Thickness of hypodermis (um)	82.8 ± 14.50	15.12 ± 11.77	59.76 ± 5.43	54. ± 8.02	53.28 ± 4.68	58.32 ± 14.68
7.	Outer cortex thickness (um)	142.5 ± 8.5	100.8 ±	118.08 ± 8.56	274.96 ± 16.59	200.9 ± 20.2	154.1 ± 9.0
8.	Length of sclerenchyma cell (um)	487 ± 154	770 ± 165	768 ± 182	1344 ± 345	1184 ± 415	2080 ± 370
9.	Breadth of scherenchyma	24.95 ± 4.1	24.9 ± 5.2	25.6 ± 10.9	22.4 ± 8.3	28.8 ± 6.4	28.8 ± 6.7
10.	No. of central vas. bundles per scape	5-6	4-5	7-8	6-7	7-10	6-8
		5.43 ± 0.5	4.9 ± 0.31	77 ± 0.48	6.4 ± 0.57	8.12 ± 1.24	6.8 ± 0.63
11.	No. of peripheral vas. bundles	12-14	9-13	16-21	24-38	26-41	24-30
	Per scape	12.85 ± 0.69	11 ± 1.49	18.85 ± 1.67	27.5 ± 4.2	32 ± 4.47	27 ± 1.94
12.	Total No. of vascular bundles	18-19	13-18	24-29	30-45	33-51	31-37
	per scape	18.3 ± 4.9	15.9 ± 1.66	26.6 ± 1.81	33.9 ± 3.9	40.1 ± 5.54	33. ± 3.4
3.	Length of vascular bundle (um)	24.3 ± 66.5	180.1 ± 20.0	231. ± 55.4	250.9 ± 43.1	289.5 ± 38.5	224.8 ± 34.79
4.	Breadth of vascular bundle(um)	141.7 ± 25.3	90.8 ± 23.3	70.8 ± 7.7	101.6 ± 40.0	129.3 ± 8.3	92.8 ± 28.3
5.	Vascular bundle size (L x B)	34473	16361	16364	25503	37434	20865

Text Fig.1(1-6) : Showing scape anatomy of *Urginea* species

Transverse section of scape of -

1) *U.congesta* x 100
2) *U.razii* x 100
3) *U.polyantha* x 100
4) *U.indica* (2n = 20) x 100
5) *U.indica* (2n = 30) x 100
6) *U.indica* (2n = 40) x 100

(E = Epidermis, GP : Ground parenchyma, H : Hypodermis, SC : Sclerenchymatous cortex, VB : Vascular bundle)



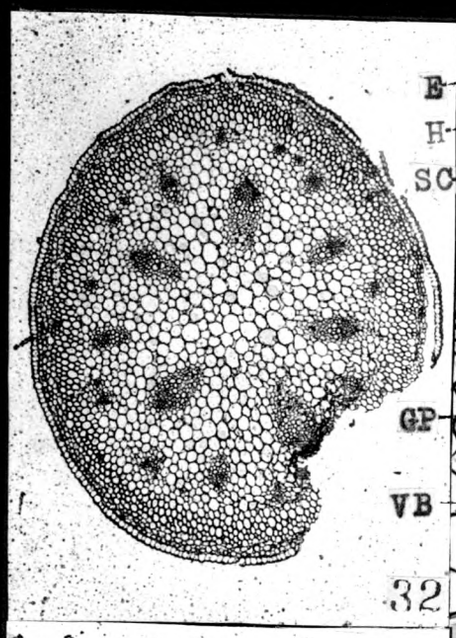
Text Fig.1-Scape anatomy of(1)Urginea congesta,(2) U. razii,(3) U. polyant (4) U. indica(2n = 20),(5) U. indica(2n = 30),(6) U. indica (2n=40).

Photoplate-V(32-40) : Showing scape anatomy of *Urginea* species

T.S.of scape of	Sclerenchymatous fibres of
32) *U.congesta* x 30	
33) *U.congesta* x 120	34) *U.congesta* x 30
35) *U.razii* x 30	
36) *U.razii* x 120	37) *U.razii* x 30
38) *U.polyantha* x 30	
39) *U.polyantha* x 120	40) *U.polyantha* x 30

(E : Epidermis, GP : Ground parenchyma, H : Hypodermis, SC : Sclerenchymatous cortex, VB : Vascular bundles).

PLATE V



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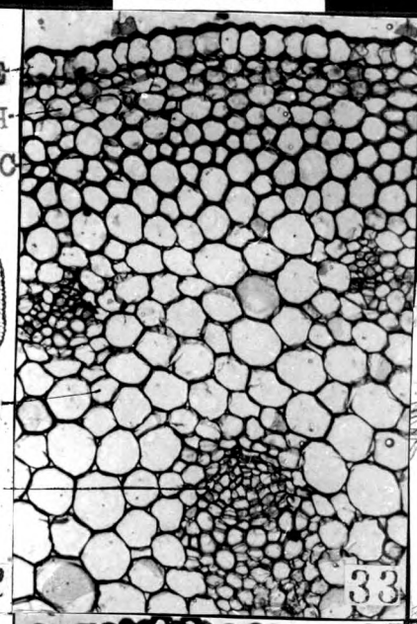

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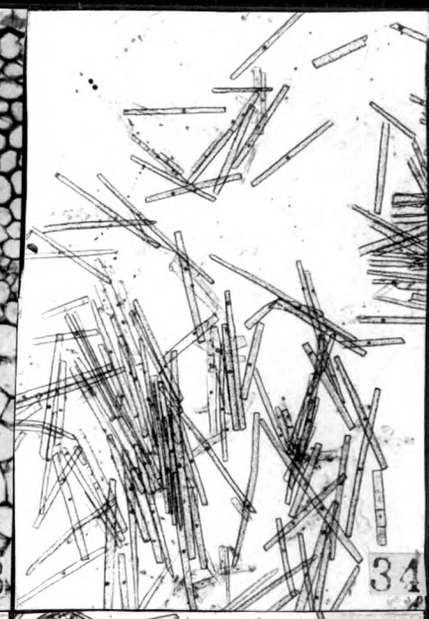

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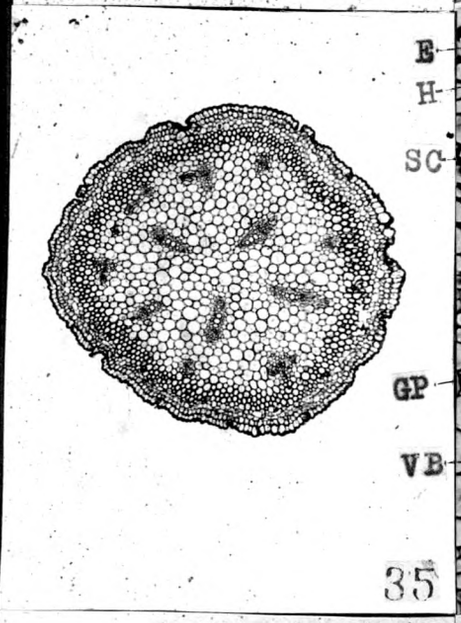

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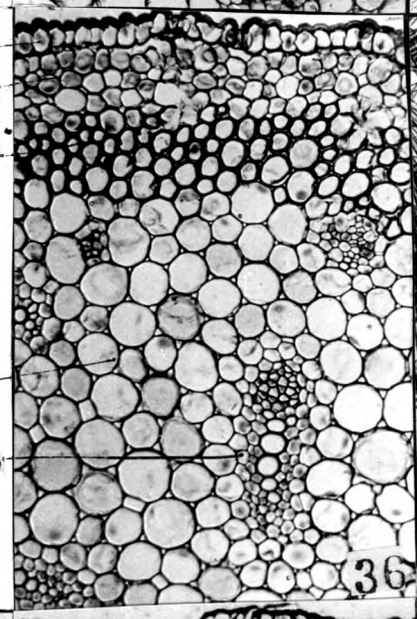

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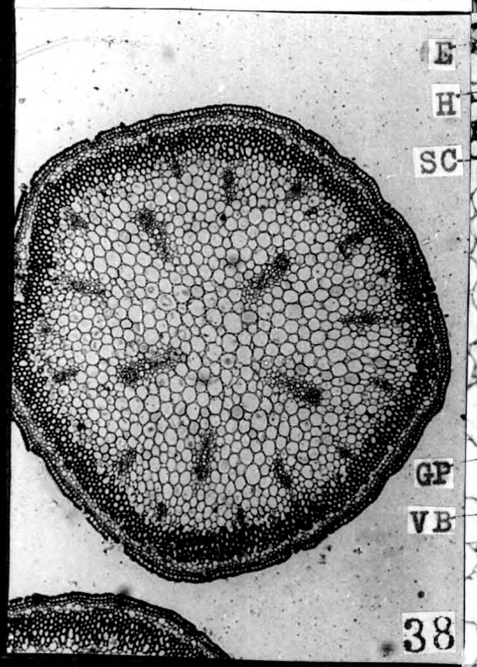

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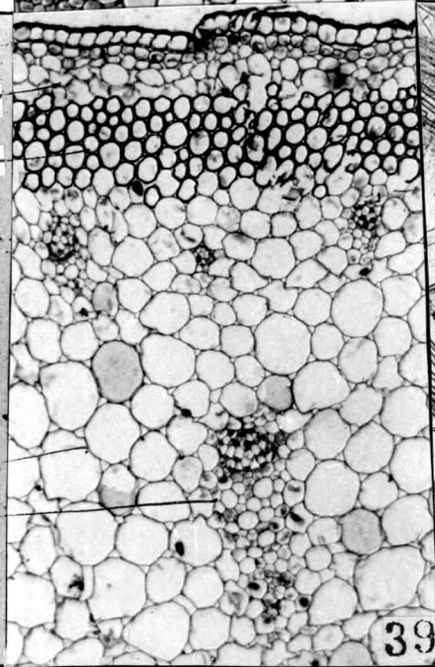

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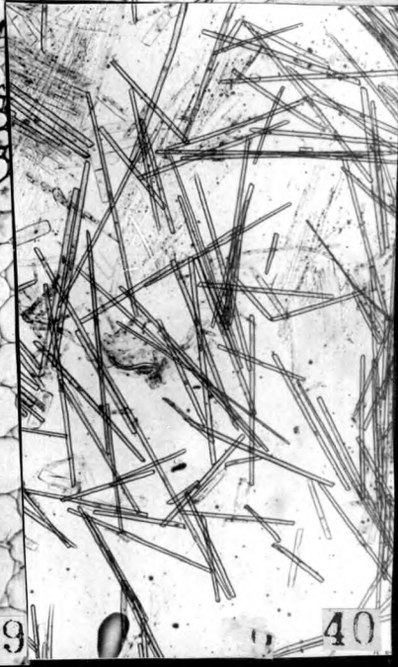

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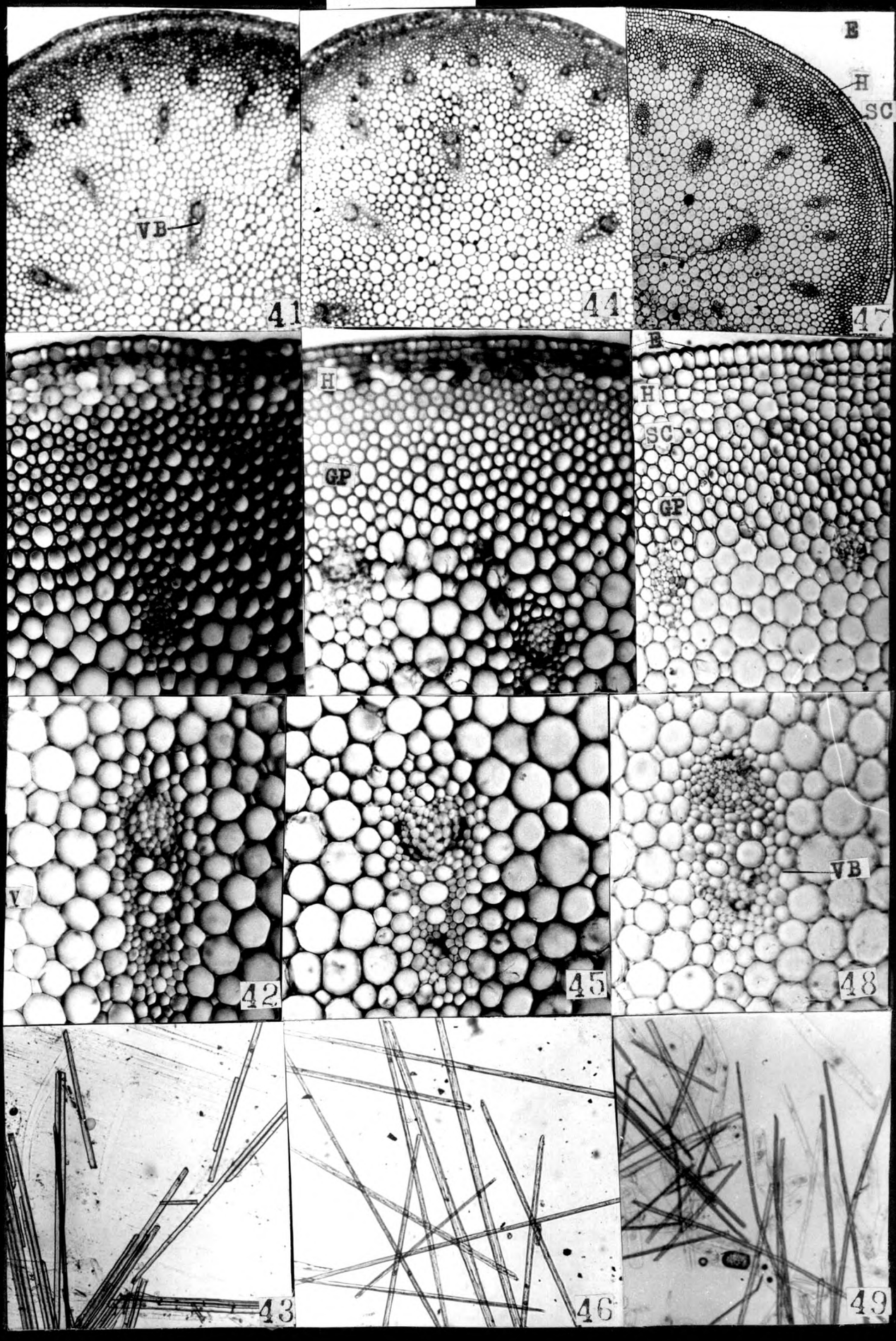
Photoplate VI (41-49) : Showing scape anatomy of *Urginea* species.

T.S.of scape of :	Sclerenchymatous fibres of :
41) *U.indica* (2n=20) x 30	
42) *U.indica* (2n=20) x 120	43) *U.indica* (2n=20) x 30
44) *U.indica* (2n=30) x 30	
45) *U.indica* (2n=30) x 120	46) *U.indica* (2n=30) x 30
47) *U.indica* (2n=40) x 30	
48) *U.indica* (2n = 40) x 120	49) *U.indica* (2n=40) x 30

(E ; Epidermis, GP : Ground Parenchyma, H : Hypodermis;
SC : Sclerenchymatous cortex; VB : Vascular bundle)

PLATE VI



(1) Scape length less than 40 cm, basal diameter of scape less than 3 mm, thickness of outer cortex less than 200 µm, fibre length less than 1000 µm, total vascular bundles per scape less than 30 in number.

(2) Scape length 6.4 ± 1.2 cm, basal diameter of scape 2.24 ± 0.41 mm, cortex thickness 42.5 ± 8 ± 5 µm, fibre cell length 487 ± 154 µm, vascular bundles per scape 11 ± 2 ... ... U.congesta

(2) Scape length 15.7 ± 3.3 cm, basal diameter of scape 1.64 ± 0.26 mm, cortex thickness 100.8 ± 15.8 µm, fibre cell length 770 ± 165 µm, vascular bundles per scape 11 ± 2 ... ... U.razii

(2) Scape length 29.6 ±8.2, basal diameter of scape 2.8 ± 0.49 µm cortex thickness 118 ± 9 µm, fibre cell length 768 ± 182 µm, vascular bundles per scape 27.0 ± 2 .... U.polyantha

(1) Scape length more than 40 cm, basal diameter of scape more than 3 mm, thickness of cortex more than 200 µm, fibre length more than 1000 µm, vascular bundles per scape more than 20 in number. ... U.indica

b) Leaf anatomy (Table 9, Fig.6 a-c, Text Fig.2(7-12), Text Fig.3(13-18), Photoplate VII 50-61). :

The anatomical characters of Urginea species have been depicted in Table 9, and shown diagramatically in Fig.6, Tex

Fig.2 and 3, and in Photoplate VII (50-61). The detailed leaf anatomy is described below.

1. U.congesta (Table 9, Fig.6, Text Fig.2-7, Text Fig.3-13, Photoplate VII 50-51) :

The leaves are linear acute and spreading on ground. The average size of leaf was found to be 20.5 ± 5.2 x 1.03 ± 0.25 cm. The average thickness of leaf was 0.94 ± 0.05 mm at base, 0.72 ± 0.6 mm in middle and 0.44 ± 0.2 mm at apex averaging to 0.73 mm. The epidermis is single layered with cuticle on outer surface. Stomata are found in both epidermises. Just below epidermis there is a single layered palisade on both side of leaf made up of vertically elongated rod shaped cells full of round chloroplasts and are slightly inclined forward (Text Fig.3-13, Photoplate VII-51). Below palisade on both sides of leaf are two layers of elongated cells which lie parallel with the surface of leaf. The central portion of leaf is occupied by large parenchymatous rectangular cells which lie parallel with surface of the leaf and do not contain chloroplasts. In this central water storage tissue lies the vascular bundles which are without sheath and the metaxylems point upwards. The average number of vascular bundles in the leaf was found to be 15.4 ± 2.8.

2. U.razii (Table 9, Fig.6, Text Fig.2.8, Text Fig.3-14, Photoplate VII 52-53) :

The leaves are erect or ascending, narrowly linear and fleshy. The average size of the leaf was found to be 15.8 ±

49 x 0.32 ± 0.09 cm. The average thickness of leaf was 1.25 ± 0.17 mm at base, 1.15 ± 0.16 µm in middle and 0.95 ± 0.12 mm at apical region averaging to 1.12 mm. The leaf has subconcave upper surface and distinctly convex lower surface with ridges and furrous on lower side (Photoplate VII 52). The epidermis is single layered with cuticle on outer surface. Stomata are found in both epidermises. Just below epidermis there is single layered palisade on both sides made up of rod-shaped cells containing chloroplasts. The palisade cells are slightly inclined forward (Text Fig.3-14, Photoplate VII 53). Below palisade there is 2 layered spongy tissue made up of cylindrical cells which lie parallel to surface of leaf and contain less number of chloroplasts as compared to palisade cells. The central region of leaf is occupied by elongated parenchymatous cells whose long axis lie parallel with leaf surface and do not contain chloroplasts. It is mainly a water storage tissue. In water storage tissue there are five main vascular bundles with few inconspicuous vascular bundles inbetween them. The average bundle number per leaf was 5.5 ± 1.69. Minimum number of vascular bundles per leaf was found in this species.

3. U.polyantha (Table 9, Fig.6, Text Fig.2-9, Text Fig.3-15, Photoplate VII 54-55) :

The leaves are broad, linear, acute and mostly spreading on ground. The average size of leaf was found to be 20.1 ± 5.8 x

1.4 ± 0.57 cm. The average thickness of leaf was found to be 0.85 ± 0.08 mm at base, 0.7 ± 0.05 mm in middle, 0.45 ± 0.029 at apical region averaging to 0.67 mm. The epidermis is single layered covered with cuticle on outer surface and possesses stomata on both surfaces. Just below epidermis there is single layered palisade made up of vertically elongated, slightly forward inclined rod-shaped cells (Text Fig.3-15, Photoplate VII 54-55) which contain numerous small oval chloroplasts. It is present on both sides of leaf. Below palisade there are 2 layers of elongated cells whose long axes lie parallel to leaf-surface and these cells contain few number of chloroplasts. In the centre there is mainly water-storage tissue which is made up of elongated rectangular cells whose long axis lie parallel to leaf surface. There are 15 ± 4 vascular bundles in the water storage tissue. The metaxylems lie towards upper epidermis.

4. U.indica (2n = 20) (Table 9, Fig.6, Text Fig.2-10, Text Fig.3-16, Photoplate VII 56-57) :

The leaves are erect or ascending, broadly linear and acute. Average size of leaf was found to be 26.9 ± 7.5 x 3.1 ± 0.54 cm. The average thickness of leaf was found to be 0.88 ± 0.2 mm at base, 0.75 ± 0.26 mm in middle and 0.55 ± 0.06 mm at apical region of leaf averaging to 0.726 mm. The epidermis is single layered covered with cuticle on its outer surface. It possesses stomata on both surfaces. Below epidermis there is a single layer of palisade made up of vertically elongated

forwardly inclined rod-shaped cells which contain numerous small, oval chloroplasts (Text Fig.3-16, Photoplate VII-57). Palisade is present on both sides of leaf. Just below palisade on both sides of leaf there is 2-3 layered spongy tissue made up of elongated rectangular cells whose long axes lie parallel to leaf surface and the cells contain few number of chloroplasts. Central portion of leaf is made up of large, elongated, rectangular cells whose long axes lie parallel to leaf surface and cells do not contain chloroplasts. There are 22 ± 5 vascular bundles per leaf in water storage tissue which run parallel with each other. The metaxylems lie towards upper epidermis.

5. U.indica (2n = 30) (Table 9, Fig.6, Text Fig.2-11, Text Fig.3-17, Photoplate VII 58-59) :

The leaves are erect or ascending, broad, linear or lorate and acute at apex. The leaf size was found to be 50.3 ± 7.5 x 2.5 ± 0.89 cm. The average thickness of leaf was found to be 1.1 ± 0.16 at base, 0.85 ± 0.09 in middle and 0.65 ± 0.04 at apex averaging to 0.87 mm. The epidermis is single layered covered with cuticle on its outer surface. It possesses stomata on both surfaces. Just below epidermis there is single layered palisade which is made up of vertically elongated forwardly inclined rod-shaped cells (Text Fig.3-16, Photoplate VII-59) which contain numerous oval chloroplasts. Below palisade layer there is 2-3 layered spongy tissue on both surfaces made up of

elongated cells which contain less number of chloroplasts. The central region of leaf is made up of large rectangular cells whose long axes lie parallel to leaf surface and constitute the water storage tissue. In water storage tissue there are 23 ± 5 vascular bundles which run parallel to each other.

6. U.indica (2n = 40) (Table 9, Fig.6; Text Fig.2-12, Text Fig.3-18, Photoplate VII 60-61) :

The leaves are erect, ascending or spreading on ground, linear, broad and acute at apex. The average leaf size observed was 20.2 ± 11.2 x 1.3 ± 0.52 cm. The average thickness of leaf was observed to be 0.95 ± 0.34 mm at base, 0.75 ± 0.22 mm in middle and 0.6 ± 0.03 mm at apex of leaf averaging to 0.77 mm. The epidermis is single layered covered with cuticle on outer surface. Just below epidermis there is a single layered palisade on both sides of leaf made up of vertically elongated forwardly inclined rod-shaped cells (Text Fig.3-18, Photoplate VII-61) which contain numerous small chloroplasts. Below palisade there are 2 layers of spongy tissue which is made up of elongated rectangular cells containing fewer number of chloroplasts. The central portion of leaf is occupied by water-storage tissue made up of elongated rectangular cells whose long axes lie parallel to leaf surface. The cells of water storage tissue do not contain chloroplasts. The vascular bundles which run parallel to each other are found in water-storage tissue and the number of vascular bundles was found to be 24 ± 6 per leaf. Metaxylems lie towards upper epidermis.

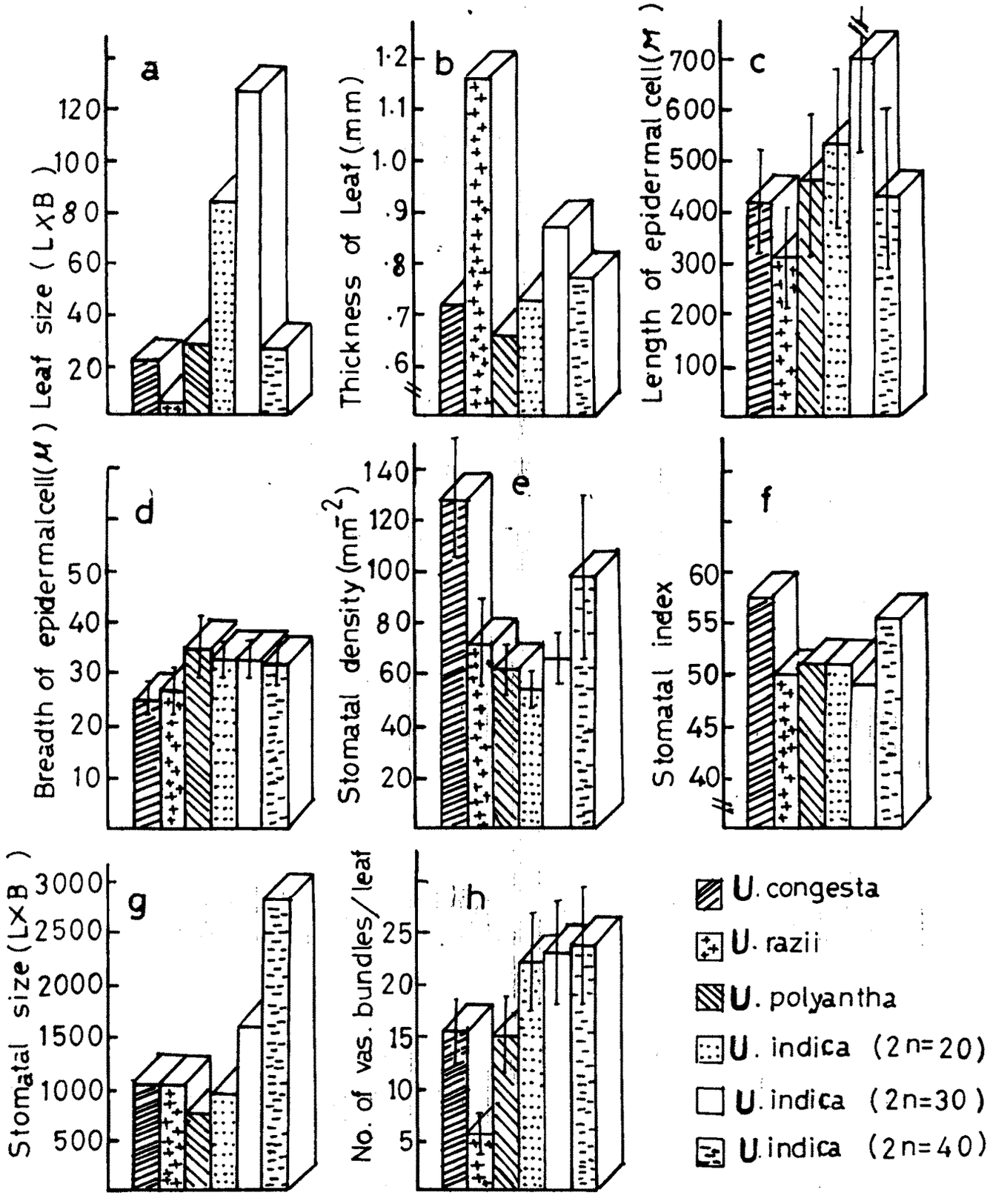


Fig-6-Cuticular and Anatomical Characters Of Leaf Of Urginea species

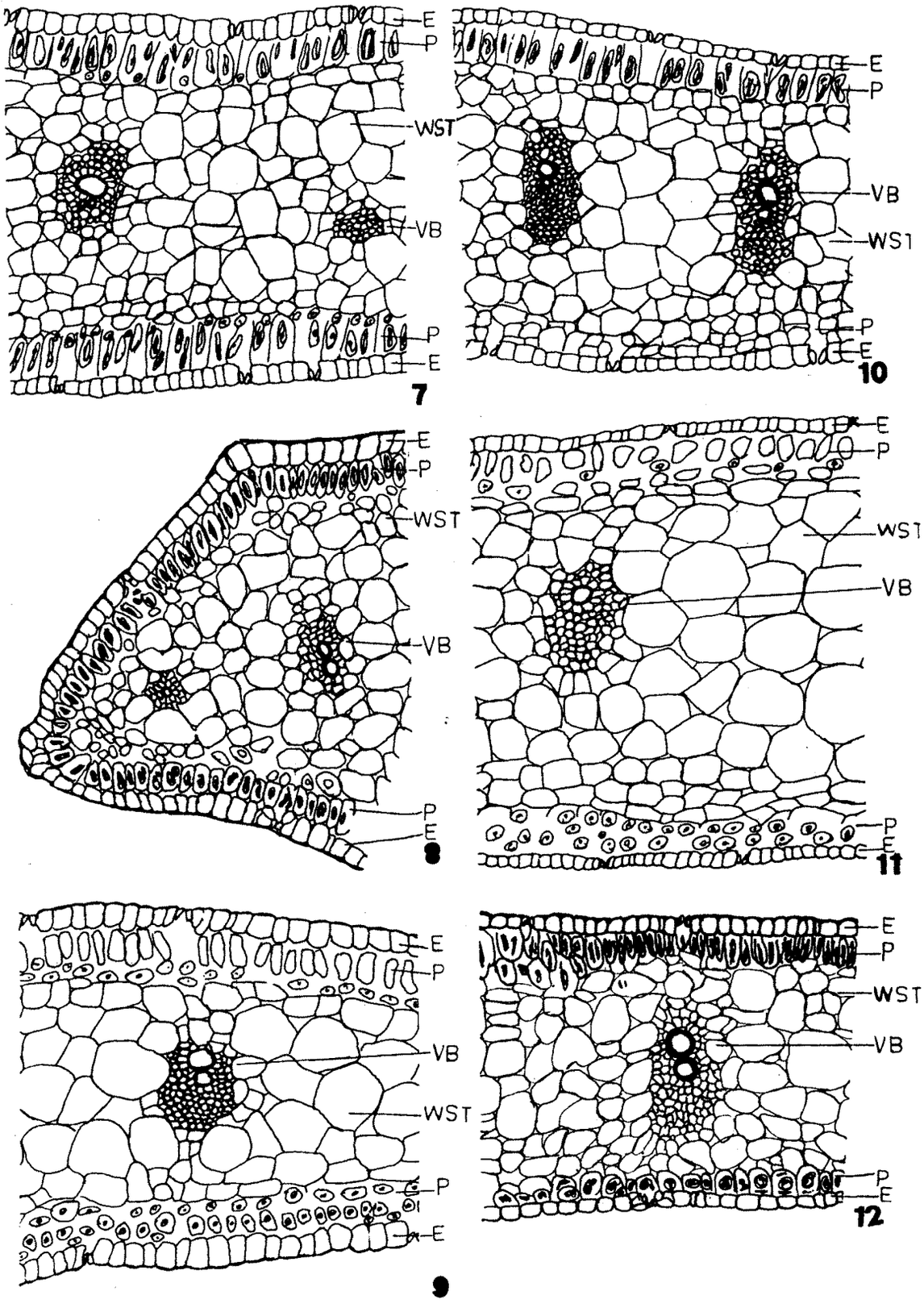
Table 9 : Showing comparative account of cuticular and anatomical characters of leaf of Urginea species

Characters	Name of the species					
	U.congesta (2n=20)	U.razii (2n=20)	U.polyantha (2n=20)	U.indica (2n = 20)	U.indica (2n=30)	U.indica (2n=40)
Leaf length(L)(cm)	20.5 ± 5.2	15.8 ± 4.9	20.1 ± 5.8	26.9 ± 7.5	50.3 ± 7.5	20.2 ± 11.2
Leaf breadth(B)(cm)	1.03 ± 0.25	0.32 ± 0.091	1.4 ± 0.57	3.1 ± 0.54	2.52 ± 0.89	1.3 ± 0.52
L x B	21.115	5.056	28.14	83.39	126.0	26.26
Thickness of leaf						
at base (mm)	0.94 ± 0.052	1.25 ± 0.17	0.85 ± 0.084	0.88 ± 0.2	1.10 ± 0.16	0.95 ± 0.34
at middle (mm)	0.72 ± 0.058	1.15 ± 0.16	0.70 ± 0.05	0.75 ± 0.26	0.85 ± 0.18	0.75 ± 0.22
at apex (mm)	0.44 ± 0.02	0.95 ± 0.12	0.45 ± 0.029	0.55 ± 0.06	0.65 ± 0 04	0.60 ± 0.029
Average thickness of leaf (mm)	0.73	1.116	0.666	0.726	0.866	0.766
No.of V.B(s)/leaf	15-18	4-9	10-19	14-30	17-32	16-30
Mean	15.4 ± 2.81	5.5 ± 1.69	15.2 ± 3.76	21.75 ± 5.25	23.0 ± 5.3	23.6 ± 5.48
Epidermal cell length (μ)	423.5 ±113.65	311.06 ±104.25	460.4 ±150.0	532.7 ±159.69	698.39 ±186.49	431.97 ±140.91
Epidermal cell breadth (μ)	25.56 ± 2.628	27.0 ± 3.024	34.92 ± 5.616	33.2 ± 2.808	32.96 ± 3.132	32.04 ± 4.608
Stomatal density						
i)On upper surface	146.5 ± 4.79	84.5 ± 2.01	68.8 ± 4.58	59.8 ± 1.81	73.8 ± 10.40	76.3 ± 12.88
ii)On Lower surface	110.3 ± 7.27	58.7 ± 1.94	55.0 ± 3.12	49.7 ± 7.0	59.3 ± 7.96	121.4 ± 13.38

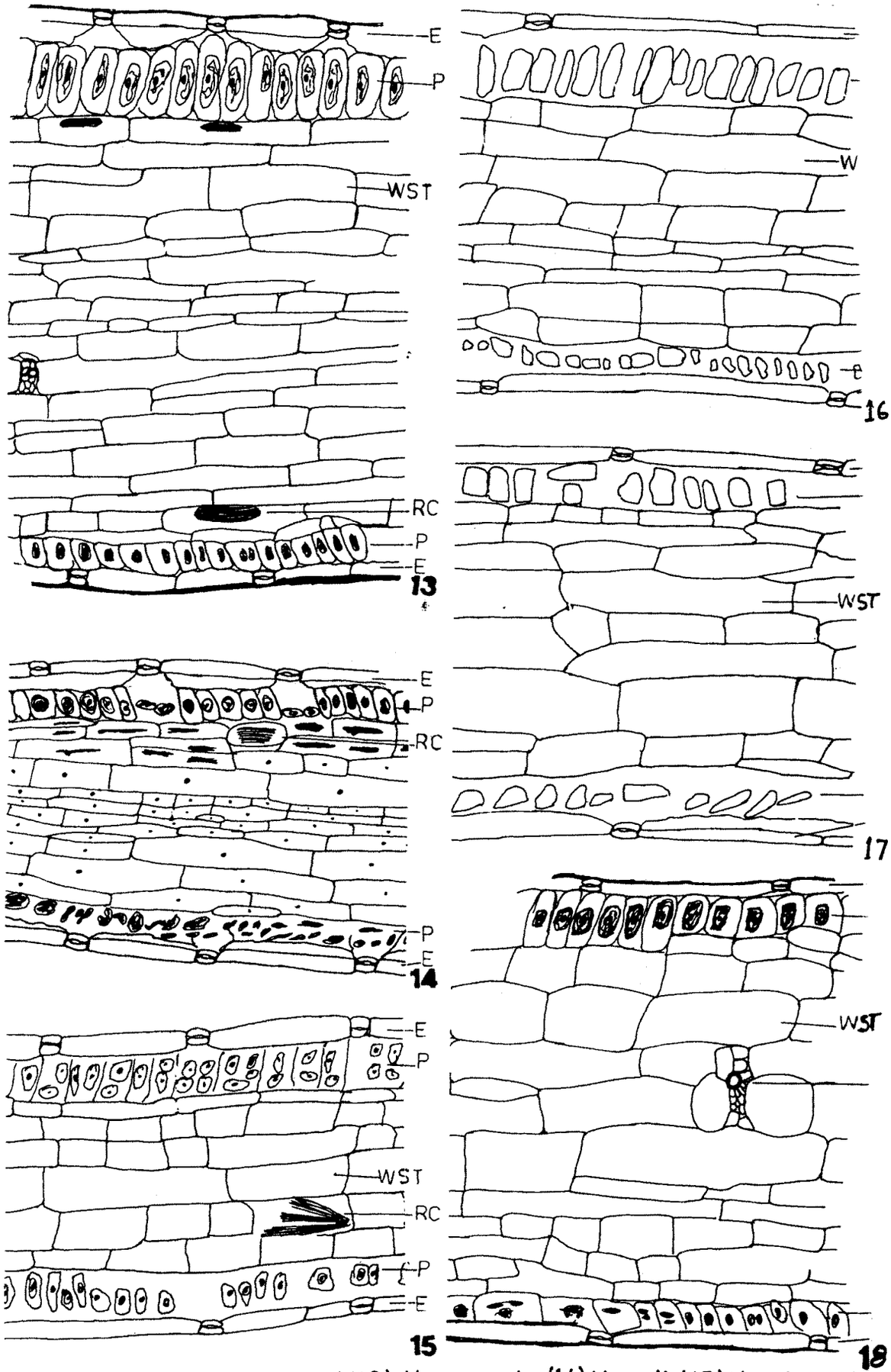
..

Table 9 : (Contd..)

Characters	Name of the species					
	U.congesta (2n=20)	U.razii (2n=20)	U.polyantha (2n=20)	U.indica (2n=20)	U.indica (2n=30)	U.indica (2n-40)
Average density of stomata	128.4 ± 25.59	72.1 ± 18.73	61.9 ± 9.75	54.7 ± 7.14	66.6 ± 10.25	98.8 ± 31.80
Stomatal index(S.I.)						
on upper epidermis	54.9	51.4	51.1	50.5	47.9	52.3
on lower epidermis	58.8	48.5	51.5	52.0	49.8	48.8
Average S.I.	56.8	49.9	51.3	51.2	48.8	50.5
Stomatal length(L) (μ)	37.44 ± 2.7	41.94 ± 4.24	32.04 ± 3.45	35.82 ± 8.60	45.18 ± 1.83	61.2 ± 2.30
Stomatal Breadth(B) (μ)	28.44 ± 3.27	26.56 ± 2.62	23.22 ± 2.44	26.82 ± 1.83	35.46 ± 2.44	45.9 ± 2.55



Text Fig. 2-Leaf anatomy of (7) Urginea congesta, (8) U. razii, (9) U. polyantha, (10) U. indica (2n=20), (11) U. indica (2n=30), (12) U. indica (2n=40).



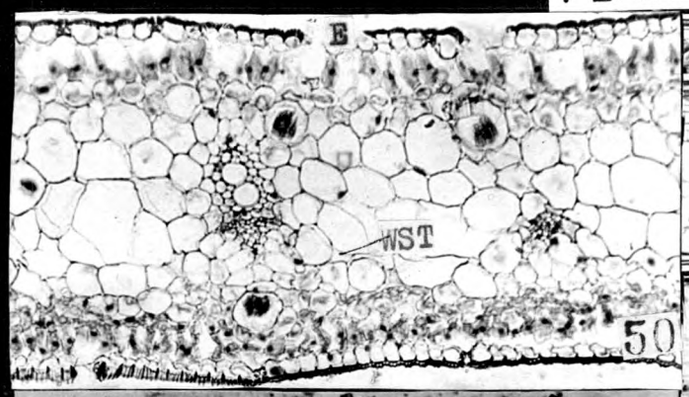
Text Fig:3-Leaf anatomy of (13) U. congesta, (14) U. razii, (15) U. polyanth. (16) U. indica (2n=20), (17) U. indica (2n=30), (18) U. indica (2n=40).

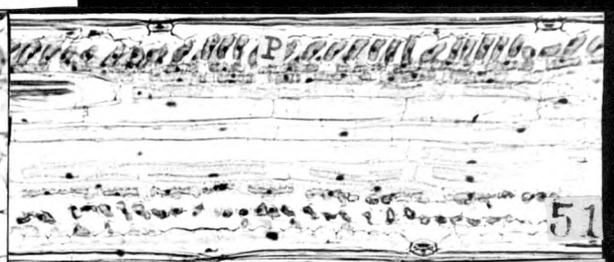
Photoplate VII (50-61) : Showing leaf anatomy of *Urginea* species.

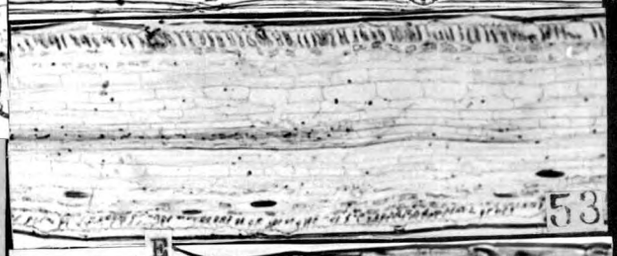
T.S. of leaf of :	L.S. of leaf of :
50) *U.congesta* x 96	51) *U.congesta* x 96
52) *U.razii* x 30	53) *U.razii* x 30
54) *U.polyantha* x 96	55) *U.polyantha* x 96
56) *U.indica* (2n=20) x 96	57) *U.indica* (2n = 20) x 96
58) *U.indica* (2n=30) x 96	59) *U.indica* (2n=30) x 96
60) *U.indica* (2n=40) x 96	61) *U.indica* (2n = 40) x 96

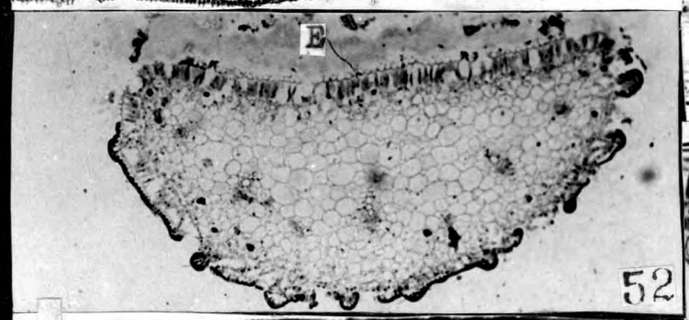
(E : Epidermis; P:Palisade, RC : Raphid cells,
VB : Vascular bundle; WST : Water storage tissue)

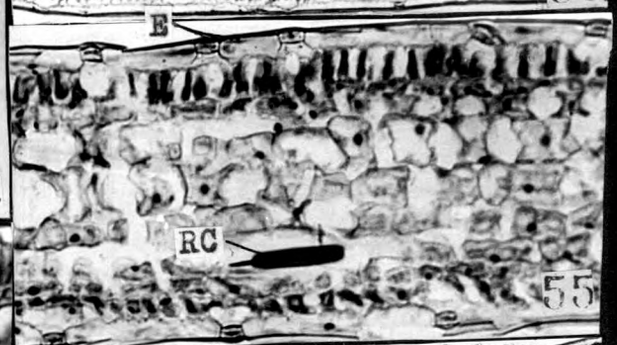
PLATE VII

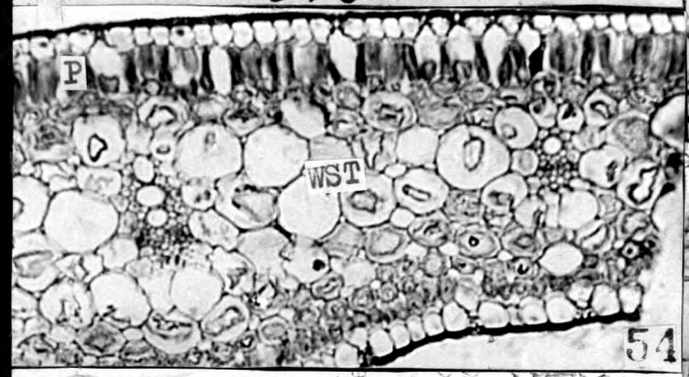

E
WST
50

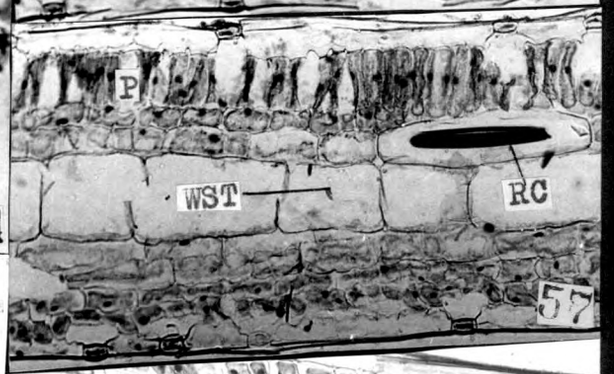

P
51

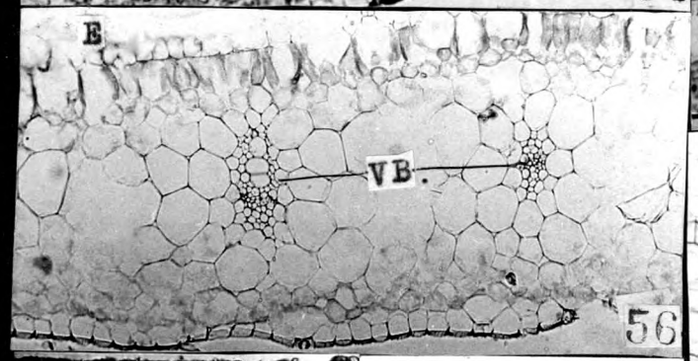

53

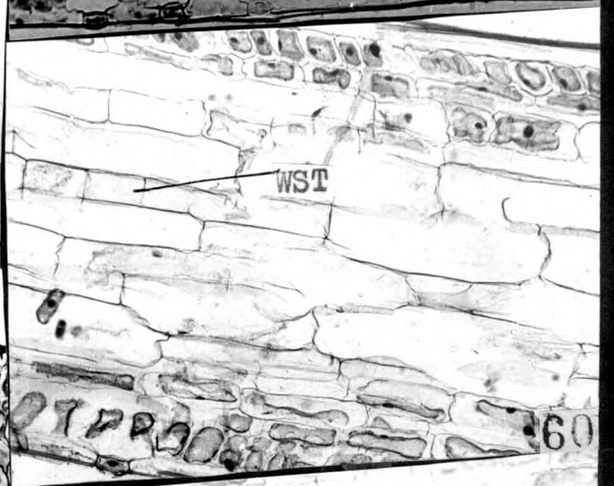

E
52

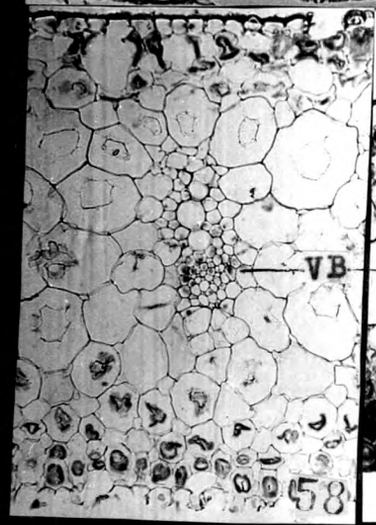

E
RC
55

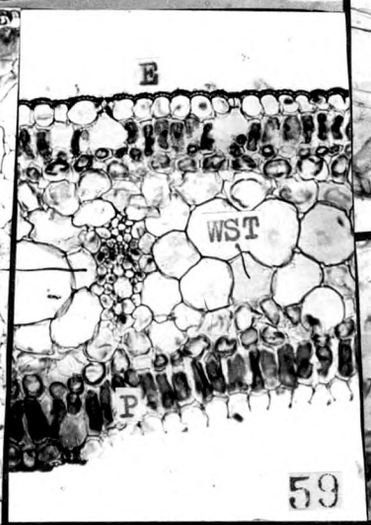

P
WST
54


P
WST
RC
57


E
VB
56


WST
60


VB
58


E
WST
P
59


61

c) Cuticle (Table 9, Fig.6, Text Fig.4:19-30, Photoplate-VII 62-79) :

All the species studied have amphistomatic leaves. The leaf epidermal cells of both abaxial and adaxial surfaces are narrow, elongated and exhibit uniform structural pattern. The size of epidermal cells, stomatal density, stomatal index and size of stomata varied in different species. The cuticular characters are depicted in Table 9 and shown in Fig.6, Text Fig.4:19-30 and Photoplate-VII (62-79). The detailed description of leaf epidermis is given below :

1. U.congesta (Table 9, Fig.6 c-h, Text Fig.4:19-20, Photoplate VII 62-64) :

The epidermal cells of leaf are narrow elongated and straight-walled (Text Fig.4:19-20, Photoplate-VIII 64-65). The average length and breadth of epidermal cell was found to be 423 ± 114 and 25.6 ± 2.6 µm respectively. Average stomatal density (Photoplate VIII:62) was found to be 147 ± 5 and 110 ± 7 mm^{-2} on adaxial and abaxial surfaces respectively. Average stomatal index on the adaxial face was found to be 54.9 while it was 58.8 on the abaxial face averaging to 56.8. There was no significant difference between stomatal index of adaxial and abaxial faces. Average size of stomata did not differ much on lower and upper faces of leaf and was found to be 37.4 ± 2.7 x 28.4 ± 3.3 µm (Photoplate-VIII : 64).

2. U.razii (Table 9, Fig.6 c-h, Text Fig.4:21-22, Photoplate VIII 65-67) :

The epidermal cells of leaf are narrow, elongated and straight-walled (Text Fig.4:21-22, Photoplate VIII:66-67). Average length of epidermal cell was found to be 311 ± 104 µm and breadth 27 ± 3 µm. Average stomatal density (Photoplate VIII 65) was found to be higher on upper surface of leaf. It was 85 ± 2 mm^{-2} on upper surface and 59 ± 2 mm^{-2} on lower surface. Average stomatal index was 51.4 on upper face and 48.5 on lower surface averaging to 49.9. Average stomatal size was found to 41.9 ± 4 x 26.6 ± 2.6 µm (Photoplate VIII 67).

3. U.polyantha (Table 9, Fig.6 c-h, Text Fig.4:23-24, Photoplate VIII : 68-70) :

Epidermal cells are narrow, elongated and straight walled, (Text Fig.4:23-24, Photoplate VIII:69-70). Average size of epidermal cell was found to be 460 ± 150 x 35 ± 5.6 µm. Average stomatal density (Photoplate VIII : 68) was found to be 69 ± 5 and 55 ± 3 mm^{-2} on adaxial and abaxial surfaces respectively averaging to 62 ± 10 mm^{-2}. There was no significant difference in stomatal index on lower and upper epidermis. Average stomatal index was found to be 51.3. Average stomatal size of both upper and lower epidermis was found to be 32 ± 3.5 x 23.2 ± 2.5 µm (Photoplate VIII : 70).

4. U.indica (2n = 20) (Table 9, Fig.6 c-h, Text Fig.4:25-26, Photoplate VIII 71-73) :

The epidermal cells are elongated, narrow and straight walled (Text fig.4:25.26, Photoplate VIII:72-73). They are larger in size with respect to other species. The average length and breadth of epidermal cell was found to be 533 ± 160 and 33.2 ± 2.9 µm respectively. Average stomatal density (Photoplate VIII:71) on lower and upper epidermis was found to be 55 ± 7 mm^{-2}. The average stomatal index on adaxial surface was found to be 50.5 while that on abaxial surface was 52 averaging to 51.2. Average size of stomata both on adaxial and abaxial surface was found to be 35.8 ± 8.6 x 26.8 ± 1.8 µm (Photoplate VIII : 73).

5. U.indica (2n = 30)(Table a, Fig.6 c-h, Text Fig.4:27-28, Photoplate VIII : 74-76) :

The epidermal cells are narrow, elongated and straight walled (Text Fig.4:27-28, Photoplate VIII:75-76). The average size of epidermal cell was found to be 698 ± 187 x 32.2 ± 2.8 µm. The average stomatal density (Photoplate VIII 74) on adaxial and abaxial surface was found to be 74 ± 10 and 59 ± 3 mm^{-2} respectively averaging to 66.6 ± 10.3. The average stomatal index was found to be 47.9 on adaxial surface and 49.8 on abaxial surface averaging to 48.8. Average stomatal size of adaxial and abaxial surface was found to be 45.2 ± 1.8 x 35.5 ± 2.4 µm (Photoplate VIII : 76).

Text Fig.4 (19-30) : Showing cuticular characters of *Urginea* species.

19) Upper epidermis of *U.congesta* x 100

20) Lower epidermis of *U.congesta* x 100

21) Upper epidermis of *U.razii* x 100

22) Lower epidermis of U.razii x 100

23) Upper epidermis of *U.polyantha* x 100

24) Lower epidermis of *U.polyantha* x 100

25) Upper epidermis of *U.indica* (2n = 20) x 100

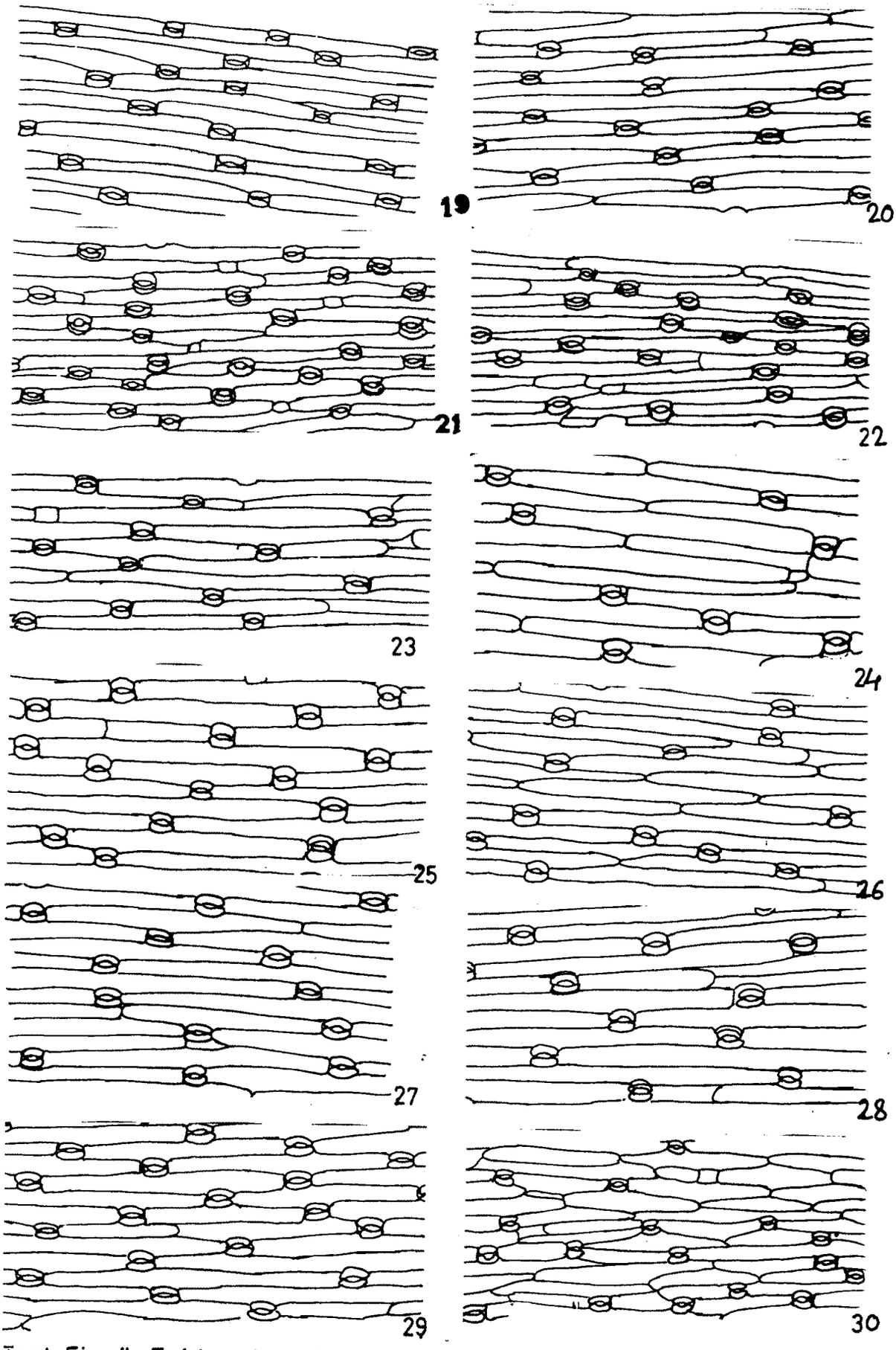
26) Lower epidermis of *U.indica* (2n = 20) x 100

27) Upper epidermis of *U.indica* (2n = 30) x 100

28) Lower epidermis of *U.indica* (2n = 30) x 100

29) Upper epidermis of *U.indica* (2n = 40) x 100

30) Lower epidermis of *U.indica* (2n = 40) x 100



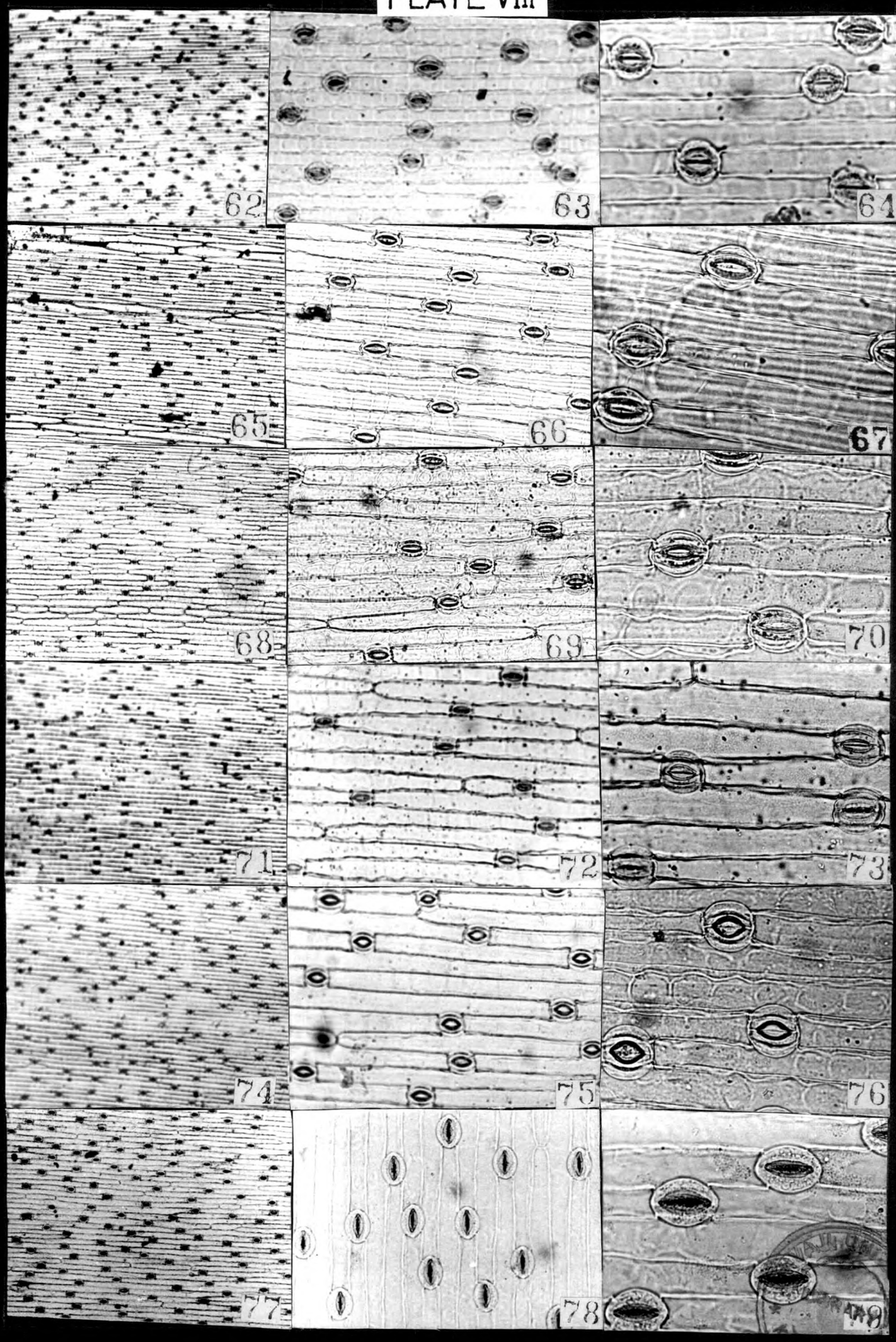
Text Fig. 4 - Epidermis and stomata of (19, 20) Urginea congesta, (21, 2 U. razii, (23, 24) U. polyantha; (25, 26) U. indica (2n = 20), (27, 28) U. indi (2n = 30), (29, 30) U. indica (2n = 40).

Photoplate VIII (62-79) : Showing cuticular characters of *Urginea* species

Epidermis of stomatal density, epidermal cells and stomata of :

62) *U.congesta* x 30
63) *U.congesta* x 120
64) *U.congesta* x 240
65) *U.razii* x 30
66) *U.razii* x 120
67) *U.razii* x 240
68) *U.polyantha* x 30
69) *U.polyantha* x 120
70) *U.polyantha* x 240
71) *U.indica* (2n=20) x 30
72) *U.indica* (2n=20) x 120
73) *U.irdica* (2n = 20) x 240
74) *U.irdica* (2n=30) x 30
75) *U.irdica* (2n=30) x 120
76) *U.indica* (2n=30) x 240
77) *U.indica* (2n=40) x 30
78) *U.indica* (2n=40) x 120
79) *U.indica* (2n=40) x 240

PLATE VIII



6. U.indica (2n = 40) (Table 9, Fig.6 c-h, Text Fig.4:29-30, Photoplate VIII : 77-79) :

The epidermal cells are narrow, elongated and straight-walled (Text Fig.4:29-30, Photoplate VIII:78-79). The average size of epidermal cell was found to be 432 ± 140 x 32 ± 4.6 µm. The average stomatal density (Photoplate VIII:77) was found to be 76 ± 13 mm^{-2} on adaxial surface and 121 ± 13 mm^{-2} on abaxial surface averaging to 99 ± 32 mm^{-2}. Stomatal index was found to be 52.03 on adaxial surface and 48.8 on abaxial side averaging to 50.5. Average stomatal size was found to be 61.2 ± 2.3 x 45.9 ± 2.54 µm (Photoplate VIII : 79).

5) Embryology :

Family Liliaceae have always been favourites for cytological and embryological studies (Schnarf, 1931; Chennaveeraiah and Mahabale, 1956; Davis, 1966). Fairly good amount of embryological work has been done on the family (Davis, 1966). Subfamily Scilloideae has received attention from embryological and taxonomical point of view (Wunderlich, 1937; Cave, 1953). However, genus Urginea has received little attension, there is no embryological work on any other species of Urginea except U.indica. Maheswari (1932) and Capoor (1937) studied microsporogenesis and megasporogenesis of U.indica, however, so far embryogeny of Urginea is unknown. From literature survey it is clear that except U.indica, there is no embryological work on other species

of Urginea and therefore, in present investigation embryology of U.razii and U.polyantha has been described. The embryological events in genus Urginea closely resemble with that of Dipcadi species (Chennaveeraiah and Mahabale, 1962). There is no marked difference in embryology of U.razii and U.polyantha and therefore, embryology of both species has been discussed together.

Phenology, Flower and its blooming, anthesis, pollination :

Both species are hysteranthus. The bulbs of both species start flowering at the end of February or in 1st week of March and it is continued upto April end. The flowers in both species are day-blooming. The flowers of U.polyantha start opening with sunrise and are fully opened by 9 a.m. In U.razii flowers start opening around 9. a.m. and become fully opened by about 10.30 a.m. The flowers of both the species remain in open condition upto 3.00 p.m. and after that start closing slowly and get closed by about 4.00 p.m. Both species are insect pollinated (Entemophilous). Around 12 a.m. when there is bright sunlight the septal nectaries secrete nectar which exudes out from each nectary and seen as three drops on ovary at three septal nectaries. During same time the stigma secretes watery substances and start glistering. In search of nectar the small insects visit flowers and bring about pollination. The anthesis (anther dehiscence) takes place around 11 a.m. on same day in U.razii while U.polyantha the anthesis takes places around 5 p.m. on previous day in closed bud.

The flowers are bisexual, regular, hypogynous. There are six perianth lobes which open wide and curve back exposing the anthers and stigma. There are 6 free stamens. Stamens are adnate to the perianth lobes at base. Ovary is tricarpellary syncarpous superior with two rows of ovules in each locule (Photoplate IX-80, Photoplate XI-102).

Microsporangium :

The anther is tetrasperangiate (Photoplate IX-80, Photoplate XI-102). It becomes biloculed by dissolution of septa between two microsporangia (Text Fig.5-40; Text Fig.8-70, Photoplate IX-88 a, Photoplate XI-109). The anther wall consists of an epidermis, endothecium, single middle layer and glandular tapetal layer (Text Fig.5:31-32, Text Fig.8:65-67, Photoplate IX:81-82, Photoplate XI:103). The epidermis and endothecium do not show any significant change upto sometime before anthesis. The ephemeral middle layer gets crushed and starts disappearing very early (Text Fig.5:33, Photoplate IX-82, Photoplate XI:104-106) when microspore mother cells enter in meiosis. The tapetum is the most prominent wall layer during (Text Fig.5:31-34, Text Fig.65-69, Photoplate IX:81-89; Photoplate XI:103-170) meiotic divisions of microspore mother cells. In early stages when there is sporogenous tissue the tapetal cells are uninucleate (Text Fig.5:31-32, Text Fig.8:65-67) but afterwards they become binucleate (Text Fig.5:33-34; Text Fig.8:68-69; Photoplate IX: 83-86; Photoplate XI:105-107). The tapetum is of secretary type and forms a prominent layer around microspore mother cells.

Microsporogenesis :

The microspore mother cells undergo normal meiotic divisions (Text Fig.5:35-39, Photoplate IX:83-86) and forms tetrads. The microspore mother cells in both species show 10 bivalents (Text Fig.5-35). The meiotic division (Cytokinesis) is of successive type and normally isobilateral pollen tetrads are formed (Text Fig.5:35-39) which is most common in monocotyledons.

Male gametophyte :

The nucleus of young pollen grain moves towards the wall and divides to form large vegetative cell and small generative cell. The generative cell moves in the centre of pollen grain and assumes a lenticular shape (Text Fig.5:40-41, Text Fig.8: 70-71) and nucleus of vegetative cells show signs of degeneration. The pollen grains are shed in 2-celled stage.

When pollen grains as well as anther matures, the endothecium develop fibrous thickening on their walls which run from inner-wall to outer wall of cell (Text Fig.5:40-41; Text Fig.8 : 70-71; Photoplate IX:86a-b, Photoplate XI:109). Epidermis get greatly stretched. Dehiscence of anther take place through well organised stomium where anther-wall breaks longitudinally and curves back (Text Fig.8-71) exposing pollen grains to the pollinators.

Megasporangium and Megasporogenesis :

The ovary is tricarpellary, syncarpous, triloculed with many ovules in two rows on axile placenta in each locule. The three septal nectaries (Text Fig.9:84) are conspicuous extending from the base to apex of ovary. The septal canal is usually lined by single layer of cells with dense cytoplasm and prominent nucleus (Text Fig.9:85). They make their appearance when the megaspore mother cell gets differentiated and are fully developed at the mature embryosac stage. In open flowers of both species, the septal nectaries secrete nectar around 12 a.m. which exudes out and is seen as three drops corresponding to three septal nectaries. After secretion the septal nectaries disorganise. Raphid cells are found in ovary as well as in style. The style is hollow and is filled with stylar secretion. Around 12 a.m. stigma secretes watery substances and stigma becomes wet. Wet stigma starts glistening in sunlight. Small insects visit flowers in search of nectar and bring about pollination.

Megasporangium :

Ovules are anatropous, bitegmic and crassinucellate. Initially ovules arise as small mounds on lateral side of placenta which grow outwards, (Text Fig.6-42, Text Fig.9:72-73; Photoplate X:90). During further development ovule undergoes a curvature of 90° and becomes anatropous. The inner integument (Text Fig.6:43, Text Fig.9:74) makes its appearence when the megaspore mother

cell is being formed where as the outer integument (Text Fig.6: 45-48, Text Fig.9:76-77) differentiates when the megaspore mother cell undergoes meiotic division (Photoplate X:92-93, Photoplate-XII:110-112). The micropyle is formed by the inner integument (Text Fig. : 49-51, Photoplate X:99, Photoplate-XII:17 & 119). The inner integument is two layered except in the region of the micropyle where it is three layered. After fertilization and during embryo development the outer integument overgrows the inner integument and completely surrounds endosperm and embryo (Text Fig.7:61). The funicular strand extends upto the base of the nucellus (Text Fig.6:51) where it connects to the group of nucellar cells (hypostase) having dense contents. The chalazal end of the embryosac endson this tissue. Nutrition to the growing embryosac and embryo is supplied through this tissue.

Megasporogenesis :

In very young ovules before integument differentiation a a hypodermal archesporial cell with a conspicuous dense cytoplasm and prominent nucleus gets differentiated (Text Fig.6:42, Text Figs.9:72, Photoplate-X:89). It soon divides periclinally forming outer primary parietal cell and an inner megaspore mother cell (Text Fig.6:43, Text Fig.9:73, Photoplate-X : 92,93; Photoplate XII:112). Rarely two archesporial initials get differentiated in same ovule (Photoplate-XII:111). The primary parietal cell divides periclinally and the parietal cells give rise to parietal tissue. The megaspore mother cell gradually increase in size and

elongates considerably. The meiosis of megaspore mother cell is normal. After first meiotic division it forms a dyad (Text Fig. 6:45, Text Fig.9:76, Photoplate-XII:113-114) and after second meiotic division give rise to a Linear (Text Fig;6:46, Text Fig. 9:77, photoplate X:94, Photoplate-XII:115) or T-shaped tetrad of four megaspores (Text Fig.6:47, Photoplate-X:95, Photoplate-XII: 116) T-shaped tetrads are of rare occurrence in D.polyantha while in D.razii it is a regular feature and about 50% ovules show T-shaped tetrads. It is the lower most chalazal megaspore of the tetrad which is functional and give rise to female gametophyte and the micropylar three megaspores degenerate (Text Fig.6:48, Text Fig.9:78, Photoplate X:96-98).

Female gametophyte :

The chalazal megaspore of the tetrad enlarges in size and a big vacuole appear in the centre of megaspore. During enlargement of functional megaspore, the inner layers of nucellus are digested and absorbed by growing megaspore undergoes first mitotic division giving rise to bimucleate embryosac (Text Fig.6:49, Text Fig.9:79, Photoplate X:99-100, Photoplate XII:117-118). Out of two nuclei are moves to the micropylar end and other to the chalazal end and cytoplasm is restricted to periphery enclosing a large vacuole at centre. Each of the nucleus undergo second mitotic division giving rise to four nucleate embryosac with 2 nuclei at each end enclosing a large central vacuole (Text Fig.6:50, Text Fig.9:80, Photoplate-120). After third mitotic

division eight nuclei are formed which soon organise into mature female gametophyte (Text Fig.6:51, Text Fig.9:83, Photoplate-X : 101, Photoplate-XII : 121).

The mature female gametophyte shows egg apparatus, secondary nucleus and three antipodal cells. The egg apparatus consists of two pointed synergids and egg. The egg is hidden between two synergids. The two polar nuclei meet somewhere in middle of embryosac and fuse to form secondary nucleus, which moves towards chalazal end and lie above the three antipodals (Text Fig.6:55, Text Fig.9:83, Photoplate-X : 101, Photoplate XII : 121). The embryosac develops a pouch at chalazal end. Antipodals lie in pouch of embryosac. In maceration technique (Text Fig.6:52-54, Text Fig.9:81-83; Photoplate-XIII : 112-127) the antipodals along with pouch get detached below secondary nucleus and remains in chalazal tissue and embryosac only with egg apparatus and secondary nucleus is seen. The antipodals in pouch vary in their arrangement. The antipodals are prominent cells with dense content, persist for a long time till the embryo and endosperm are fairly well developed .

A elevated mound like outgrowth is developed at the base of funiculus on placenta which is lined by columnar epithelial cells with dense cytoplasm and dark staining ability. It lies near the micropyle of ovule and serves as a bridge for pollen-tubes to enter into the ovule (Text Fig.6:51, Photoplate XII:117-118 & 120). This obturator guides the growth of pollen tube towards micropyle.

Both species are entemophilous. The stigma get pollinated between 12 a.m. to 2 a.m. and it was observed that the pollen tubes reach the ovules and enter through micropyle into an ovule by about 5 p.m. The pollen grains soon germinate on stigmatic surface and pollen tubes which grow in group and creep along stylar canal. Fertilization in both species is porogamous. The pollen tube enters in one of the synergids of embryosac. After fertilization the synergids persist for some time and finally disappear.

Endosperm :

The development of the endosperm is of the helobial type. The first division of the primary endosperm nucleus is followed by a wall resulting in smaller chalazal chamber and larger micropylar chamber. Few nuclear divisions take place in chalazal chamber while nucleus of micropylar chamber undergoes several divisions forming large number of free nuclei distributed along peripheral region. The wall formation is centripetal. In final stage the entire endosperm becomes cellular. The inner layers of endosperm is digested and absorbed by growing embryo.

Embryogeny :

(Text Fig.7:61, Text Fig.9:86-92, Text Fig.7:56, Text Fig. 9:86, Photoplate XIII:122). The zygote enlarges slightly and the nuclear division is followed by formation of transverse wall giving rise to small apical cell (Ca) and larger basal cell (Cb) (Text Fig.7:57, Text Fig.9:87). Cell Cb divides transversally forming two superposed cell Ci and m (Text Fig.9:88). The cell Ca

divides by vertical wall forming two juxtraposed cells. Another vertical wall at right angle to first wall in Ca results in 4 cells. (Text Fig.7:59, Text Fig.9:89-90). The four apical cells undergoes a transverse division forming two tiers each with 4 cells. Same time cells Ci and m divide transversally forming a suspensor. Periclinal divisions take place in both apical tiers forming a globular embryo (Text Fig.7:58-60, Text Fig.9:89-91, Photoplate XIII:129-134). The globular embryo grows and forms cylindrical embryo which reaches the chalazal end of seed (Text Fig.7:63). However the embryo development has not been studied in sufficient detail and therefore, type of embryo development is not yet decided and the work is in the progress.

Seed Structure :

The seeds are oval to elliptical, winged and compressed. The testa is black and shining seeds are endospermic with large cylindrical embryo.

The large cylindrical embryo is surrounded by endosperm. Endosperm is made up of rectangular cells full of reserve food material (Text Fig.7:62-63). The cells are usually arranged in rows. The testa is free from endosperm. It is made up of three layers. The inner two layers of testa is made of parenchymatous cells. The outermost layer of testa is made up of large irregularly shaped cells. At time of seed maturity when seed coat become black develops fine reticulate ornamentation (Text Fig.7: 64) and become black.

Text Fig.5 (31-41) : Showing microsporangium, microsporogenesis and male gametophyte of *Urginea razii*

T.S. of anther showing -

31 & 32) Sprogenous tissue and wall layers x 480

33) Wall layers, degenerated middle layer, binucleate tapetal cells and microspore mother cell's x 480.

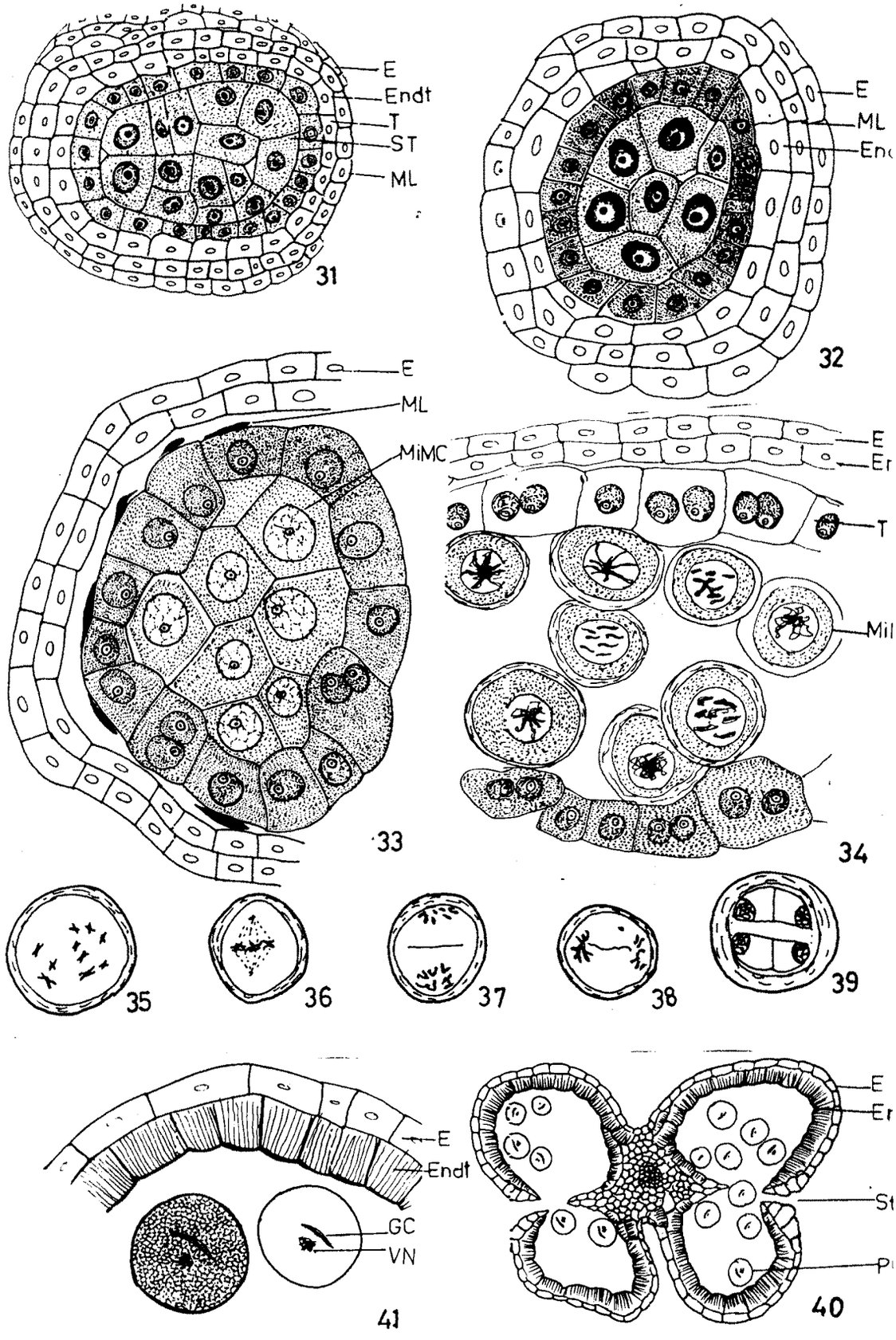
34) Microspore mother cells in prophase x 480

35 - 39) Successive stages of meiosis of microspore mother cell x 480

40) T.S. of anther showing pollen grains, epidermis, endothecium and stomium x 100

41) Sector of T.S. of anther enlarged showing epidermis, endothecium with fibrous thickening and binucleate pollen grains x 480.

(E : Epidermis, Endt : Endothecium, GC : Generative Cell, ML : Middle layer, MiMC : Microspore mother cells, PG : Pollen grains, ST : Sporogenous tissue, Sto : Stomium, T : tapetum, VN : Vegetative nucleus).



Text Fig 5-Microsporangium, microsporogenesis and male gametoph of Urginea razii 31-41.

Text Fig.6 (42-55) : Showing megasporangium, megasporogenesis and female gametophyte of Urginea razii.

L.S. of ovule showing -

42) megaspore mother cell x 480

43) megaspore mother cell, parietal cell and initiation of inner integument x 480

44) Megaspore mother cell in meiosis first x 480

45) Dyad and initiation of inner integument x 480

46) Linear tetrad x 480

47) T-shaped tetrad x 480

48) Three micropylar megaspores and enlarging chalazal megaspore x 480

49) Binucleate embryosac x 480

50) Four nucleate embryosac x 480

51) Obturator funiculus hypostase and eight nucleate embryosac (Reconstructed) x 100

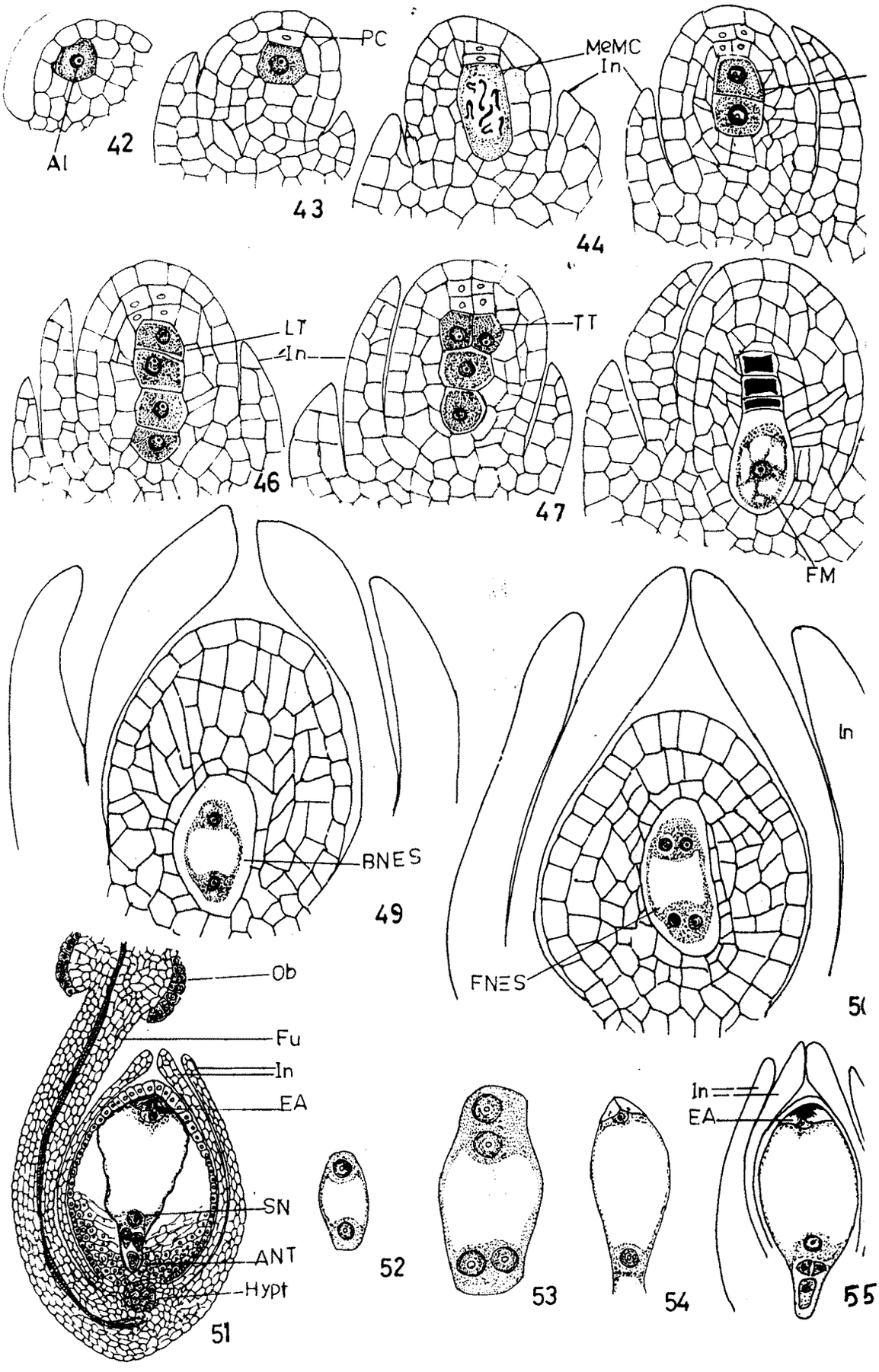
52) Binucleate embryosac x 480

53) Four nucleate embryosac x 480

54) Embryosac x 100

55) Mature embryosac x 100

(AI : Archesporial initial, ANT : Antipodals, BNES : Binucleate embryosac, Dy : Dyad, EA : Egg apparatus, FM : Functional megaspore, FNES : Four nucleate embryosac, Fu : Funiculus, Hypt : Hypostase, In : Integament, LT : Linear tetrad, MeMC : Megaspore mother cell, Ob : Obturator, PC : Parietal Cell, SC : Secondary nucleus, TT : T-shaped tetrad).



Text Fig. 6 - Megasporangium, megasporogenesis and female gametc of Urginea razii 42-55.

Text Fig.7 (56-64) : Showing embryo development, endosperm and seed structure of Urginea razii.

56) Zygote x 480

57) Transverse division of Zygote x 480

58 & 59) Young embryo x 480

60) Globular embryo x 225

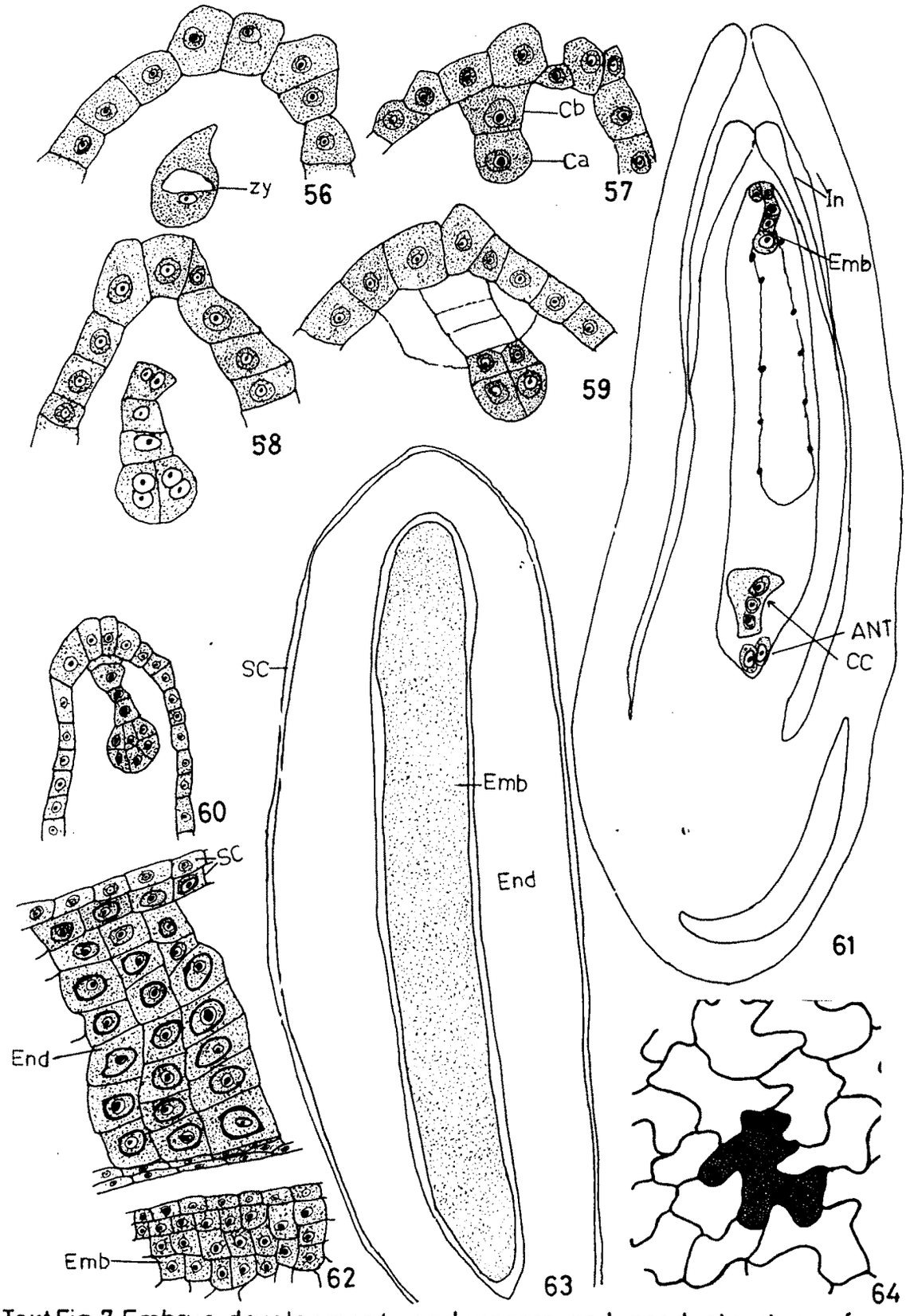
61) L.S. of ovule showing two integuments, young embryo, endosperm nuclei, chalazal chamber and two antipodals x 100

62) Sector of T.S. of seed x 480

63) L.S. of ovule showing cylindrical embryo, endosperm and seed coat x 100

64) Surface ornamentation of seed coat.

(ANT : Antipodal, Ca : Apical Cell, Cb : Basal Cell, CC : Chalazal chamber, Emb : Embryo, End : Endosperm, In : Integument, Sc : Seed Coat).



Text Fig 7-Embryo development, endosperm and seed structure of Urginea razii 56-64.

Text Fig.8 (65-71) : Showing microsporangium and microsporogenesis of Urginea polyantha.

T.S. of anther showing :

65) Sporogenous tissue x 480

66) Wall layers and sprogenous tissue x 480

67) Wall layers, tapetum and sprogenous tissue x 480

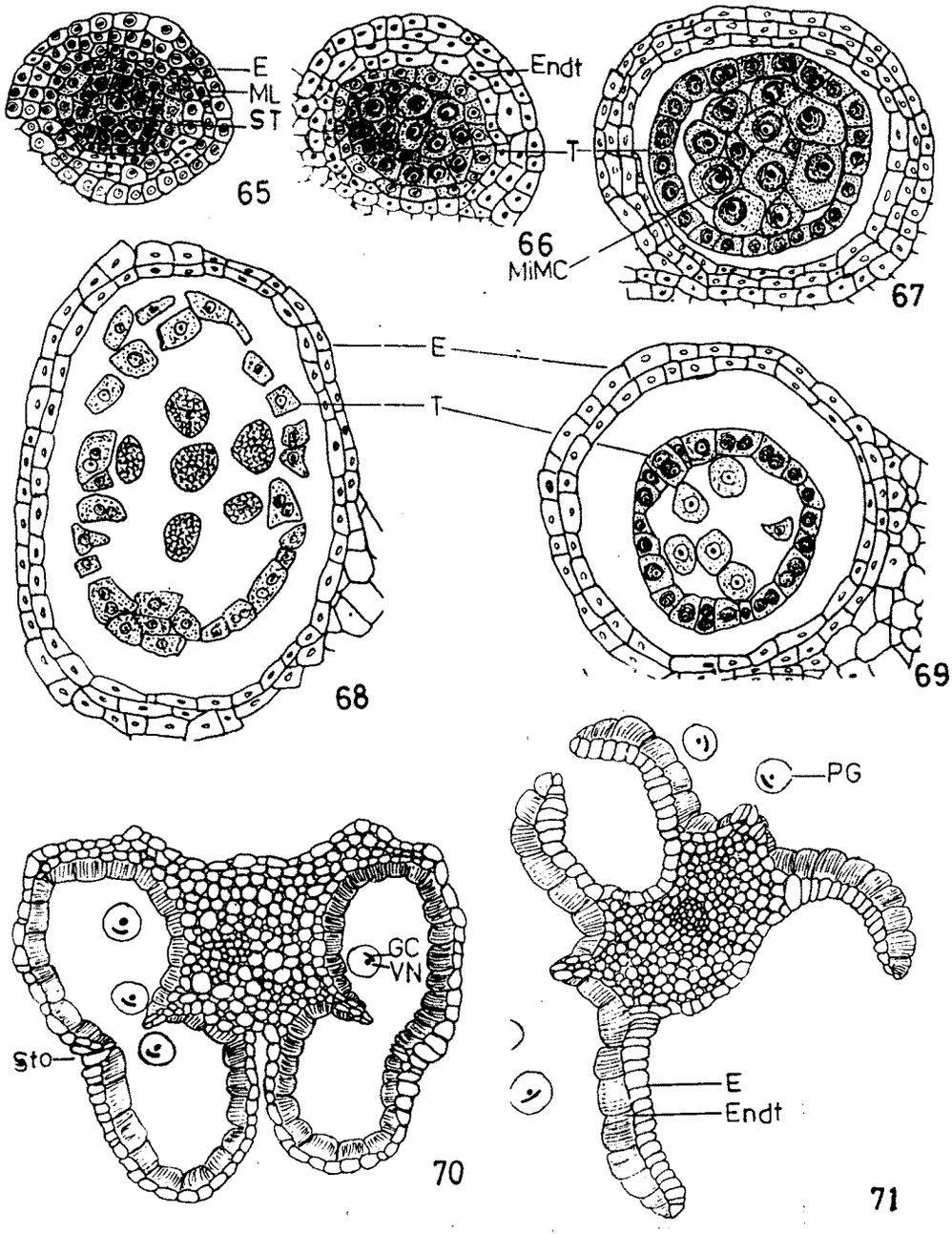
68) Epidermis, endothecium, bimucleate tapetal cells and microspore mother cell x 480

69) Epidermis, endothecium, bimucleate tapetal cells and young pollen grains x 480

70) T.S. of undehisced anther showing epidermis, endothecium and bimucleate pollen grains x 100

71) T.S. of dehisced anther showing fibrous endothecium and bimucleate pollen grains x 100

(E : Epidermis, Endt : Endothecium, GC : Generative Cell, MiMC : Microspore mother cell, ML : Middle layer, PG : Pollen grains, Stom : Stomium, T : Tapetum, VN : Vegetative nucleus).



Text Fig 8-Microsporangium and microsporogenesis of Urginea polyantha 65-71.

Text Fig.9 (72-92) : Showing megasporogenesis, female gamelophyte and embryo development in Urginea polyantha.

L.S. of ovule showing :

72) Megaspore mother cell x 225

73) Megaspore mother cell and parietal cell x 225

74 & 75) Inner integument and enlarging megaspore mother cell x 225

76) Outer and inner integument and dyad x 225

77) Linear tetrad of four megaspore x 225

78) Enlarging chalazal megaspore x 225

79) Binucleate embryosac x 225

80) Four nucleate embryosac x 225

81) Binucleate embryosac x 480

82) Four nucleate embryosac x 100

83) Mature embryosac x 100

84) T.S. of flower bud x 45

85) Sector of wall showing septal nectary x 480

86) L.S. of ovule showing Zygote x 480

87) Transverse division of zygote x 480

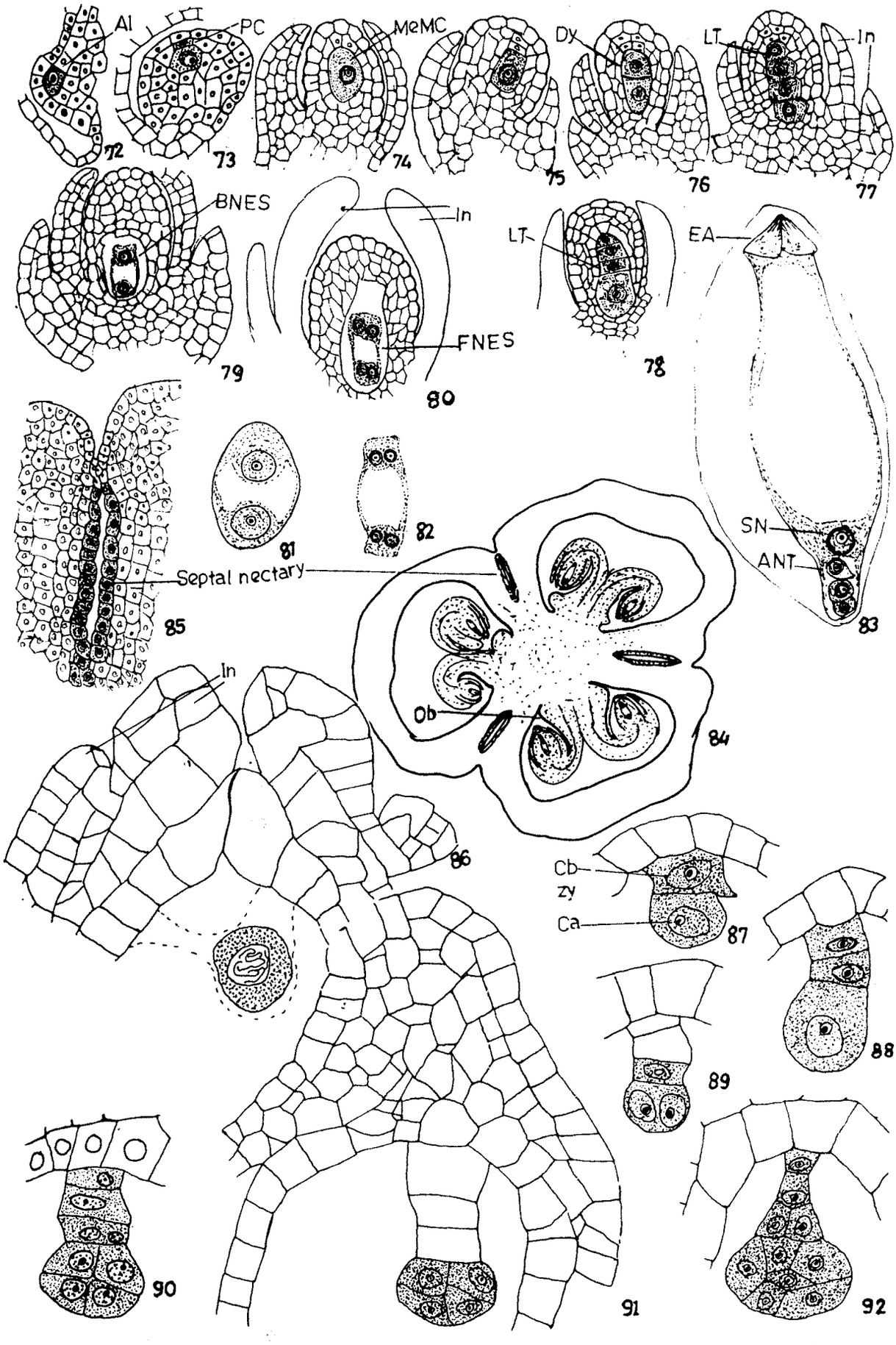
88) Transverse division in basal cell of proembryo x 480

89) Divisions in apical cell x 480

90 & 91) Young embryo and micropyle closed by inner integument x 480

92) Globular embryo x 480.

(AI : Archesporial initial, ANT : Antipodal, BNES : Binucleate embryosac, Dy : Dyad, EA : Egg apparatus, FNES : Four nucleate embryosac, In : Integument, LT : Linear tetrad, MeMC : Megaspore mother cell, SN : Secondary nucleus).



Text Fig 9.-Megasporogenesis female gametophyte and embryo-development in Urginea polyantha 72-92.

Photoplate IX (80-88) : Showing microsporangium, microsporogenesis and male gametophyte of Urginea razii.

80) T.S. of flower bud x 37.

T.S.of anther showing -

81) Sporogenous tissueand wall layers x 240

82) Sporogenous tissue, degenerating middle layer and bimucleate tapetal cells x 240.

L.S. of anther showing -

83) Wall layers, tapetum and microspore mother cells in Meiosis x 120.

84) Microspore mothers cells in diplotene and bimucleate tapetum x 240.

85) Microspore mother cells at anaphase I x 240

86) Microspore mother cells at diakinesis x 240

T.S. of anther showing -

87) Pollen tetrads x 120

88 a) Stomium, epidermis, endothecium and pollen grains x 240

88 b) Wall of anther showing epidermis and fibrous endothecium x 240

(E : Epidermis, Endt : Endothecium, MiMC : Microspore mother cells, ML : Middle layer, PG : Pollen grains, ST : Sporogenous tissue, STO : Stomium, T : Tapetum).

Photoplate X (89-101) : Showing megasporangium, megasporogenesis and female gametophyte of Urginea razii.

89) L.S. of ovary showing row of ovules with megaspore mother cell x 240

L.S. of ovule showing -

90) Megaspore mother cell x 240

91) Megaspore mother cell and initiation of inner integument x 240

92) Megaspore mother cell and distinct inner integument x 240

93) Enlarged megaspore mother cell and initiation of outer integument x 240

94) Linear tetrad x 240

95) T-shaped tetrad x 240

96) Enlargement of middle megaspore of tetrad as abnormality x 240

97-98) Enlarged chalazal megaspore x 240

99-100) Binucleate embryosac x 240

101) Mature embryosac x 120.

(AI : Archesporial initial, ANT : Antipodals, BNES : Binucleate embryosac; DY : Dyad, EA : Egg apparatus, FNES : Four nucleate embryosac, Fu : Funiculus; In : Integument, LT : Linear tetrad, TT : T-shaped tetrad; PC : Parietal cell; Ob : Obturator, SN : Secondary nucleus).

Photoplate XI (102-109) : Showing microsporangium, microsporogenesis of Urginea polyantha.

102) T.S. of flower bud x 37.

T.S. of anther showing

103) Sporogenous tissue and wall layers x 150

104) Sporogenous tissue and distinct tapetum x 150

105) bimucleate tapetal cells and microspore mother cellx x 150

106) bimucleate tapetum cells and microspore mother cells in meiosis I x 150

107) Microspore mother cells at diakinesis x 150

108) Pollen tetrads x 150

109) Epidermis, fibrous endothecium, stomium and pollen grains x 96.

(E : Epidermis; Endt : Endothecium; MiMC : Microspore mohter cells, ML : Middle layer; PG : Pollen grains; ST : Sporogenous tissue; Sto : Stomium; T : Tapetum).

Photoplate XII (110-121) : Showing megasporangium, megasporogenesis and female gametophyte of Urginea polyantha.

L.S. of ovule showing -

110) Megaspore mother cell x 558

111) Initiation of inner integument and two megaspore mother cells x 290

112) Enlarged megaspore mother cell and distinct inner integument x 465

113) Dyad x 290

114) Dyad x 465

115) Linear tetrad of four megaspores x 240

116) T-shaped tetrad x 240

117) Enlarging megaspore and oburator x 240

118) & 119) Binucleate embryosac x 240

120) Four nucleate embryosac x 240

121) Mature embryosac x 120

(AI : Archesporial initial; ANT : Antipodals; BNES : Binucleate embryosac; Dy : Dyad; EA : Egg apparatus; FNES : Four nucleate embryosac; Fu : Funiculus, In : Integuments; LT : Linear tetrad; PC : Parietal Cell; Ob : Obturator; SN : Secondary nucleus; TT : T-shaped tetrad).

Photoplate XIII (122-134) : Showing embryosac and embryo-development of Urginea polyantha.

122) Unimucleate embryosac x 744

123) Binucleate embryosac x 744

124) Fournucleate embryosac x 744

125) Eight nucleate embryosac x 744

126) & 127) Mature embryosac without antipodals x 225

Free nuclear endosperm with -

128) Zygote x 120

129) Young embryo x 120

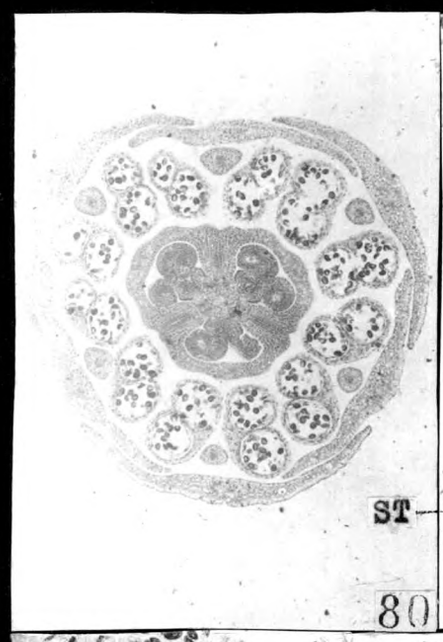
130) Large micropylar and small chalazal chamber and young embryo x 384

131) Young embryo x 225

132) 133) 134) Young embryo showing successive stages of development x 225.

(EA : Egg apparatus; Emb : Embryo; End : Endosperm, SN : Secondary nucleus, ZY : Zygote)

PLATE IX



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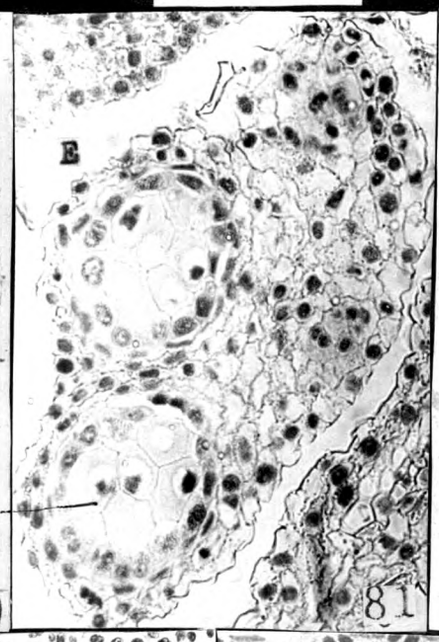

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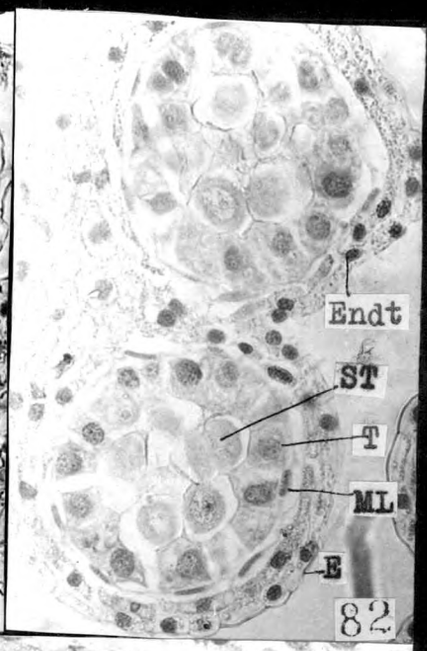

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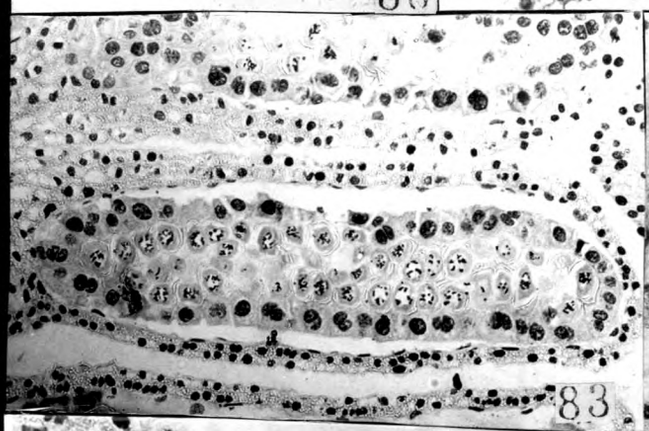

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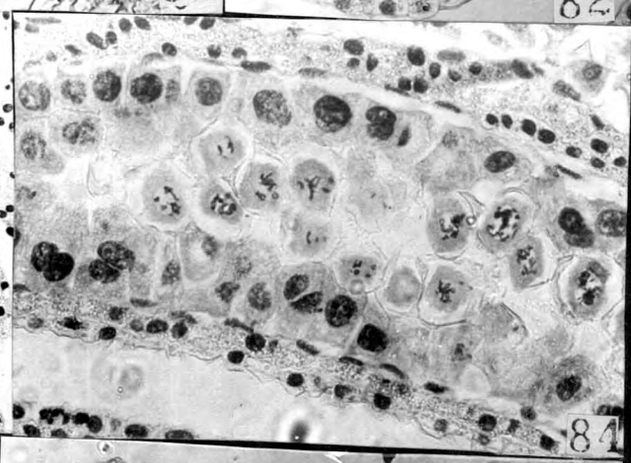

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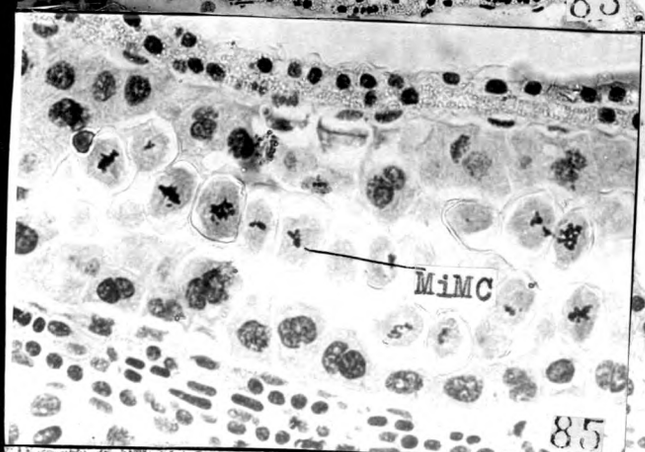

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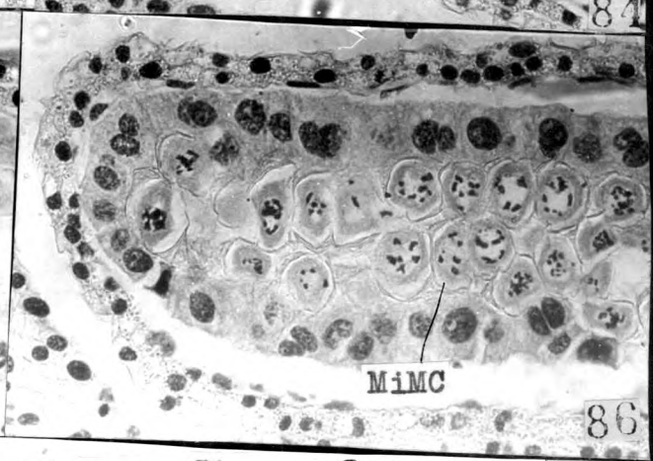

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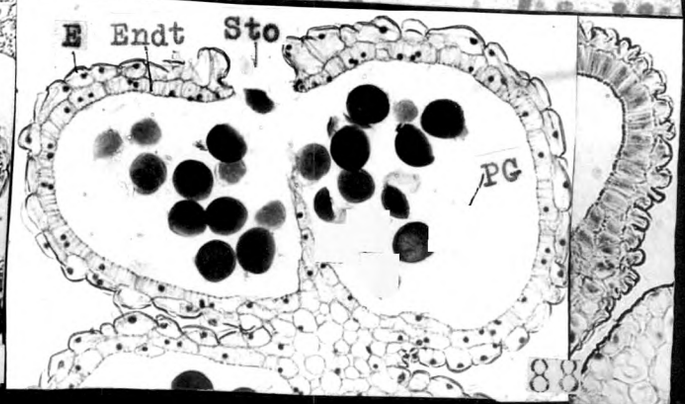

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PLATE X


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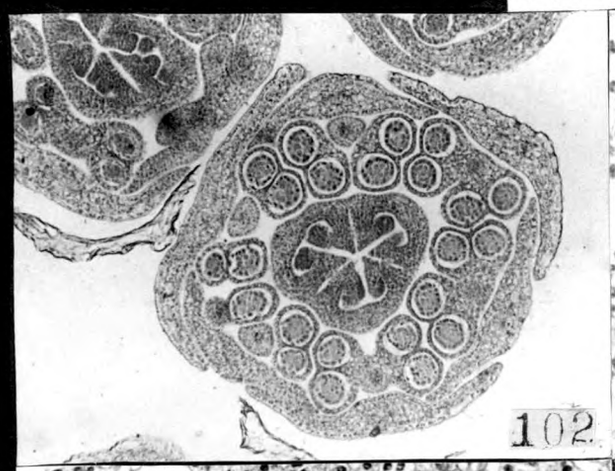
101

PLATE XI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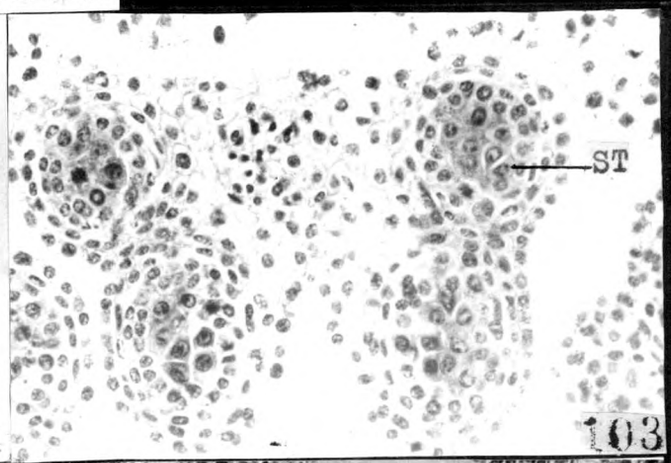

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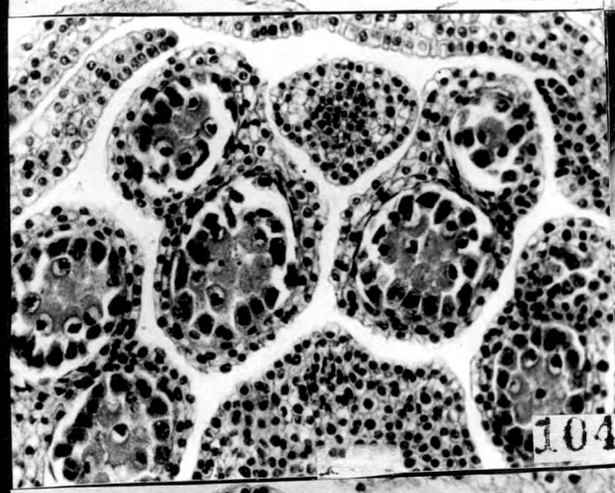
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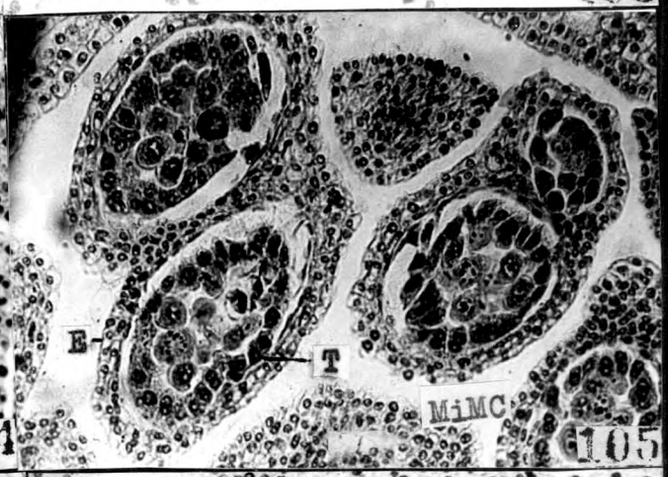

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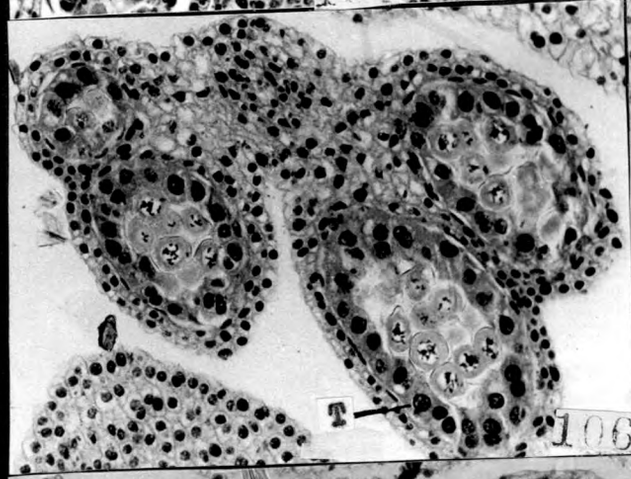

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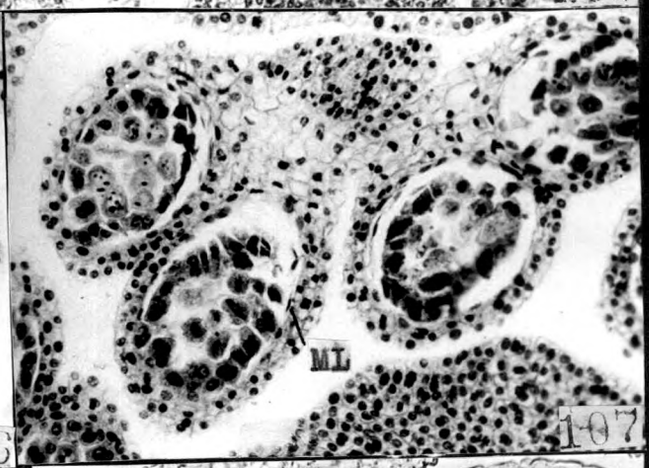

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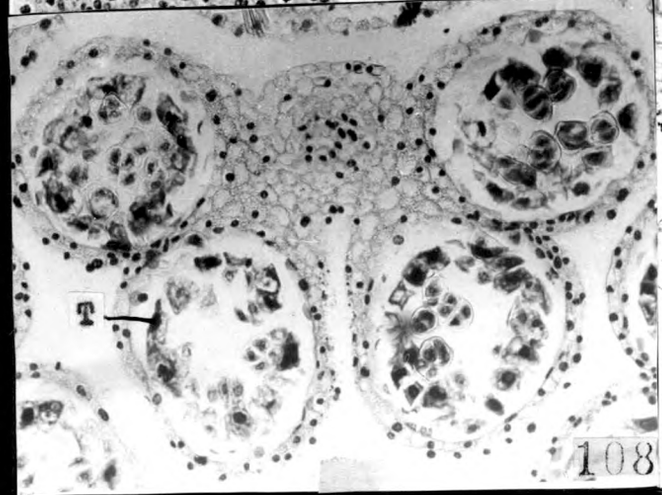

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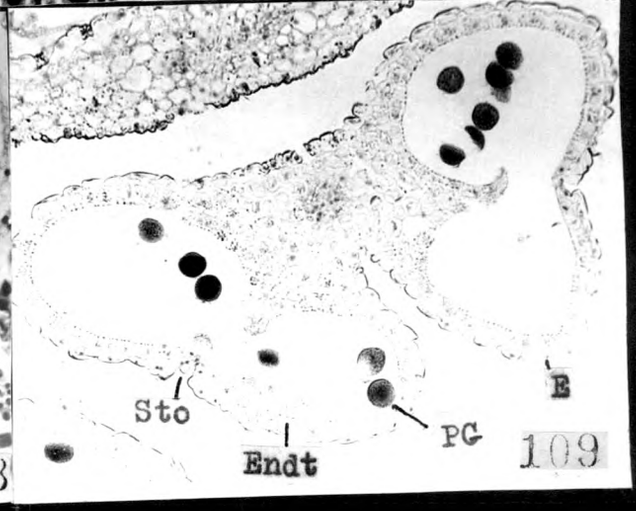

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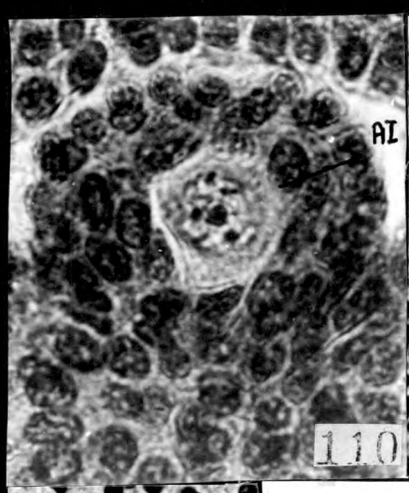
PLATE XII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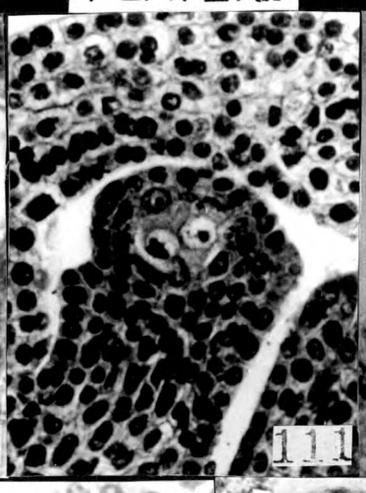
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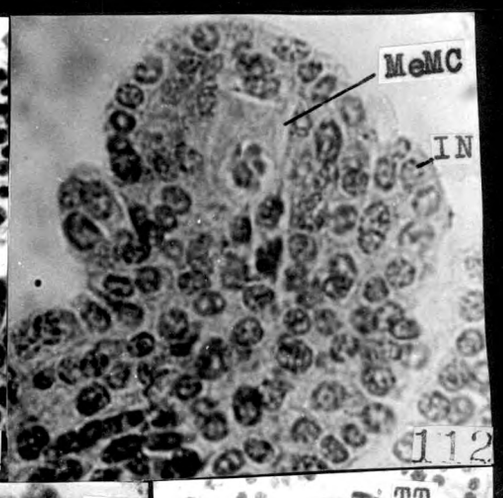
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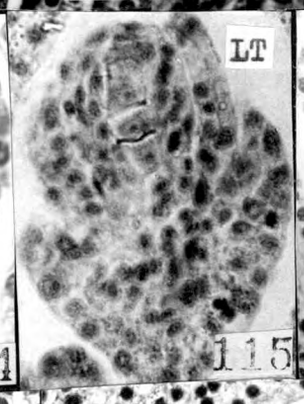
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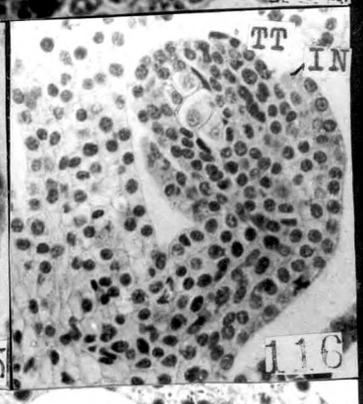
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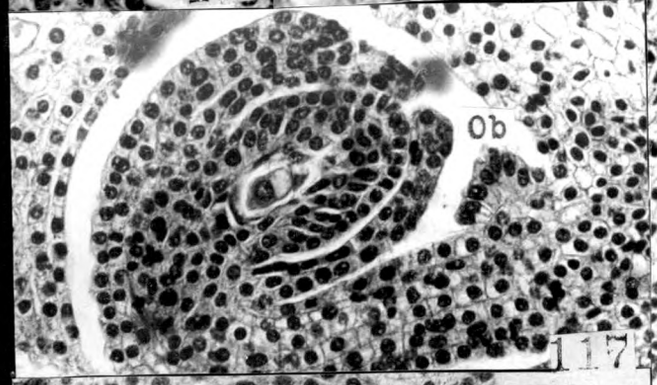
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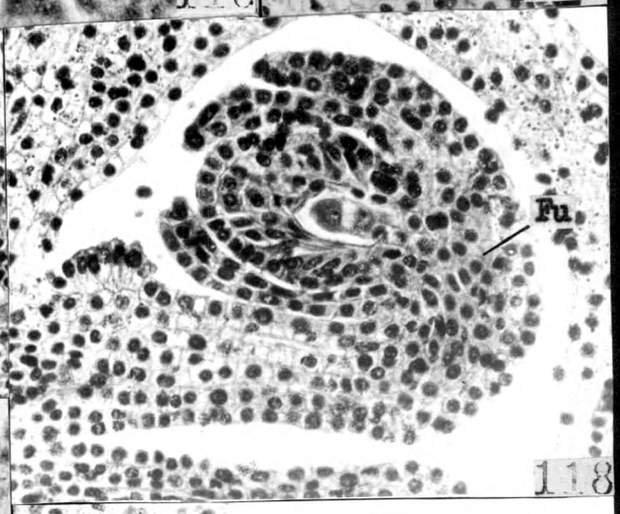
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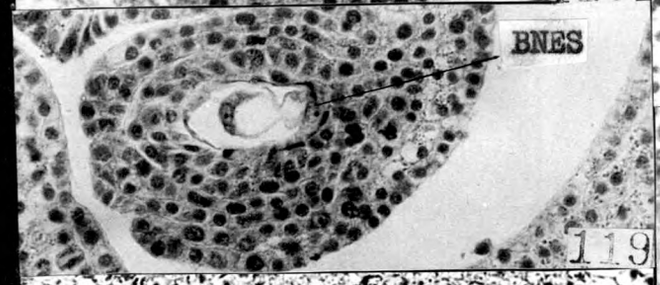
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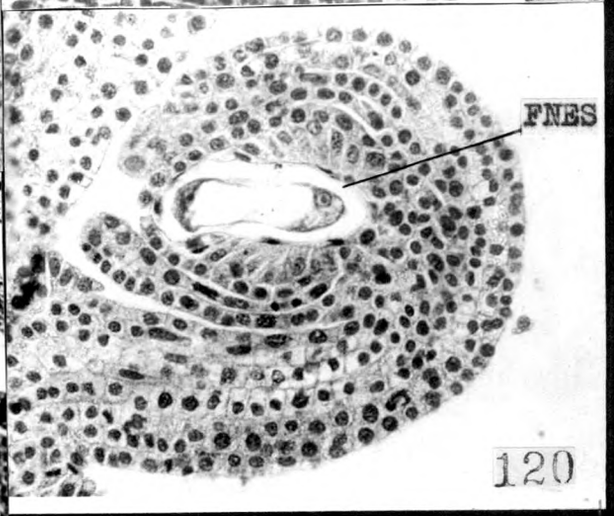
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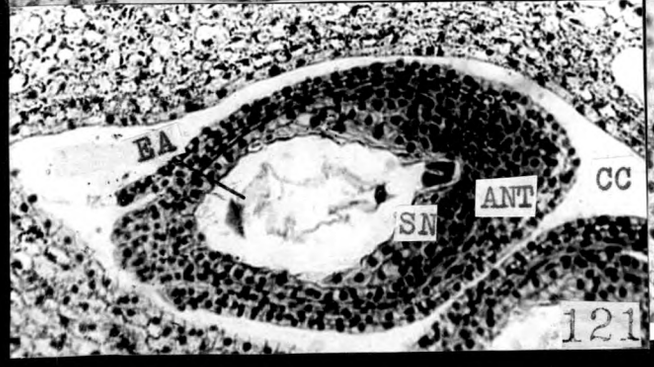
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CC
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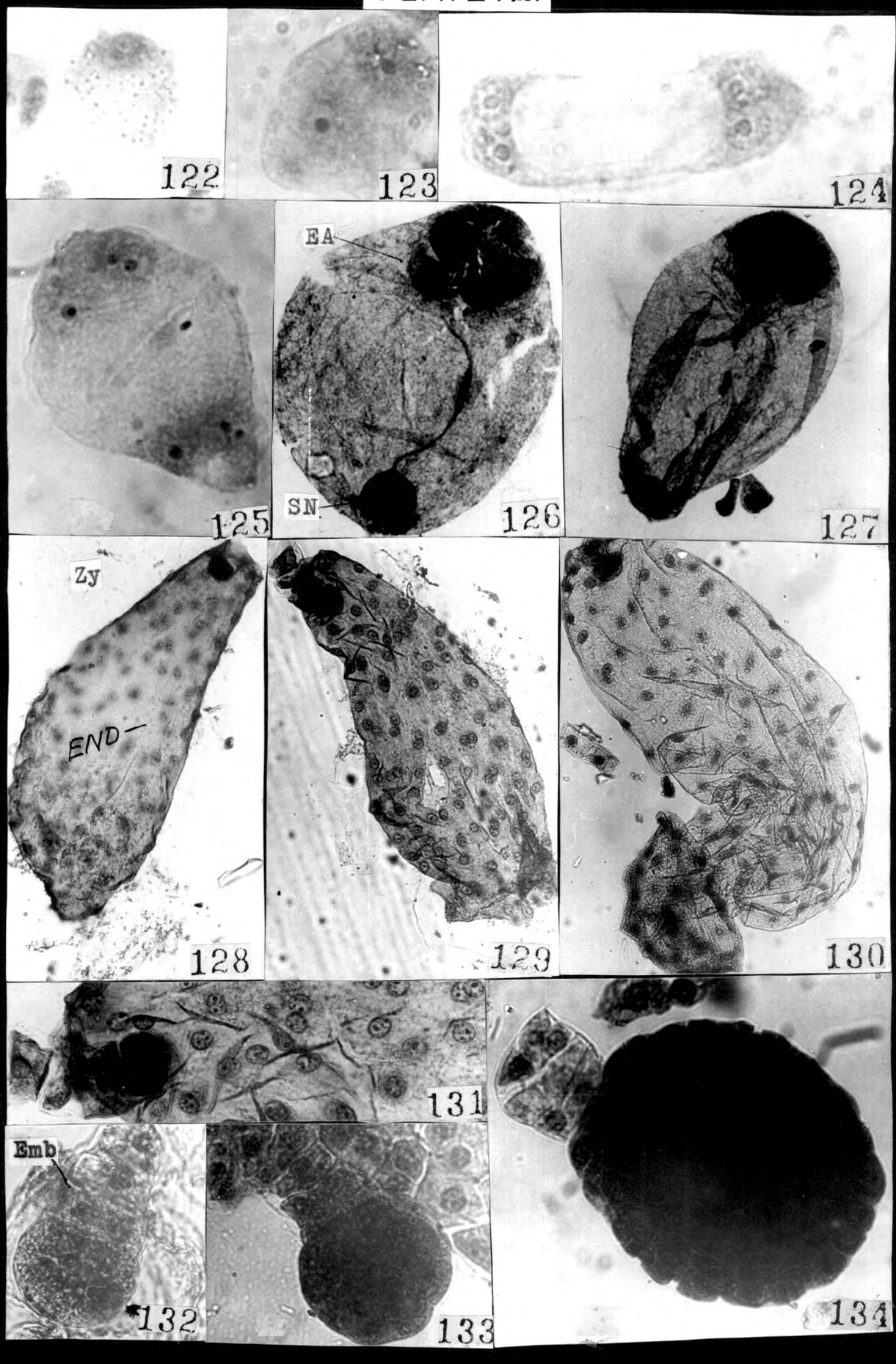
PLATE XIII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