

## III. Observations

Field observations showed that it is difficult to identify species of Crinum especially in vegetative stage. The characters of species overlap and there are no good taxonomic characters to distinguish them. Similarly natural interspecific hybridization further complicates the problem of identification of species. Different reports of species ranging from 60 to 165 in the genus Crinum by different taxonomists indicate the problem of species recognition and delimitation in the genus. Therefore, it was felt essential to describe the morphology of each species in detail and to find out better characters of taxonomic importance.

Genus Crinum is represented by about 12 species in India viz. Crinum amoenum, C. asiaticum, C. brachynema, C. defixum, C. eleonora, C. humile, C. latifolium, C. pratense, C. pusillum, C. stracheyi, C. wattii and C. woodrowii. Of the 12 species 7 occur in Maharashtra viz. Crinum asiaticum, C. brachynema, C. defixum, C. eleonora, C. latifolium, C. pratense and C. woodrowii. Crinum brachynema, C. eleonora and C. woodrowii are endemic to the state. All the three species restricted to Mahabaleshwar hills are in endangered state and need immediate attention for their conservation.

Detailed descriptions of C. asiaticum, C. brachynema, C. defixum, C. eleonora, C. latifolium, C. pratense, C. woodrowii and Crinum (tetraploid,  $2n = 44$ )

species are given below. Most of these species are cultivated in Botanical Garden of Botany Department of Shivaji University. The descriptions of the species are based on literature, field studies and observations on plants grown in Botanical Garden. In addition to detailed descriptions, distribution, phenology, and economic importance of each species is given below. Key to identify the Crinum species of Maharashtra is provided at the end.

#### Diagnostic characters of the genus Crinum

Herbs with tunicated bulbs; the bulbs often produced into a long or short neck; leaves numerous, elongate, lorate or ensiform; scape solid; flowers large, umbellate; bracts 2, spatheaceous, bracteoles linear; flowers sessile or subsessile, funnel or salver shaped, long; perianth tube straight or curved; perianth lobes 6; linear to lanceolate or oblong, spreading or conniving; stamens 6, on throat of the perianth tube; filaments free, filiform; anthers linear, dorsifixed; ovary 3-celled; ovules few to many in each cell; style filiform; stigma minute, subcapitate; capsule irregularly subglobose, membranous or coriaceous, bursting irregularly; seeds few, large rounded, testa thick; albumen copious, fleshy. Species: 150 (Wahlstrom and Laane, 1979). Distributed widely in tropical and subtropical regions of world.

1. Crinum asiaticum Linn. Sp. pl. 292. 1753; Hook f. fl. Brit. India 6 : 280. 1892. Cooke T. Fl. Pres.

Photoplate - I ( 1-4 )

Showing plant parts of Crinum species

1. C. asiaticum - Vegetative and flowering stage.
2. C. brachynema - vegetative stage
3. C. defixum -vegetative stage
4. C. defixum - flowering stage

Photoplate - II ( 5-8 )

Showing plant parts of Crinum species

5. C. latifolium - Vegetative stage
6. C. latifolium - Flowering stage
7. C. pratense - Vegetative stage
8. C. pratense - flowering stage

Photoplate - III ( 9.11 )

Showing plant parts of Crinum species and pollination  
agent-Hawkmoth

9.     C. spp (tetraploid  $2n=44$ ) - Vegetative stage
10.    C. spp (tetraploid  $2n=44$ ) - Flowering stage
11.    Hawk-moth (spingid moth) - Agent of pollination

Photoplate - IV (12-17)

Showing pollen chracters and wall ornamentation of Crinum  
species (Acetolysed pollengrains)

Group of pollengrains	Single pollengrain
12. <u>C. asiaticum</u> X 120	13. <u>C. asiaticum</u> X 240
14. <u>C. defixum</u> X 120	15. <u>C. defixum</u> X 240
16. <u>C. latifolium</u> X 120	18. <u>C. pratense</u> X 240
17. <u>C. pratense</u> X 120	20. <u>C. woodrowii</u> X 240
19. <u>C. woodrowii</u> X 120	22. <u>C. spp</u> (2n= 33) X 240
21. <u>C. spp.</u> (2n=33) X 120	24. <u>C. spp</u> (2n=44) X 240
23. <u>C. spp.</u> (2n=44) X 120	

Photoplate - V (25-30)

Showing Leaf anatomy of Crinum species

- 25. C. asiaticum X 96
- 26. C. brachynema X 96
- 27. C. defixum X 30
- 28. C. latifolium X 96
- 29. C. pratense X 96
- 30. C. tetraploid X 96

(E= Epidermis, H: Hypodermis, VB= vascular bundles)



Photoplate - VI (31-38)

Showing cuticular characters and vessels of Crinum  
species

Stomata

Vessels

- |                                   |                                  |
|-----------------------------------|----------------------------------|
| 31. <u>C. brachynema</u> X 240    | 32. <u>C. brachynema</u> X 128   |
| 33. <u>C. latifolium</u> X 120    | 34. <u>C. latifilium</u> X 128   |
| 35. <u>C. pratense</u> X 240      | 36. <u>C. pratense</u> X 80      |
| 37. <u>C. Spp</u> (2n = 44) X 240 | 38. <u>C. spp</u> (2n= 44) X 128 |

Photoplate - VII ( 39-45 )

Showing somatic chromosome number in Crinum species and B  
- chromosomes in C. pratense

Somatic chromosomes

39. C. brachynema ( $2n = 22$ ) X 4000

40. C. latifolium ( $2n = 22$ ) X 4000

B - chromosomes

41. C. pratense ( $2n = 22+1B$ ) X 4000

42. C. pratense ( $2n = 22+ 2B$ ) X 4000

43. C. pratense ( $2n= 22+3B$ ) X 4000

44. C. Pratense ( $2n = 22+4B$ ) X 4000

45. C. spp ( $2n = 44$ ) X 4000

Photoplate - VIII (46-51) : Showing different stages of  
meiosis in C. defixum

- 46. Bivalents, diakinesis
- 47. Bivalents, diakinesis
- 48. Mataphase I
- 49. Bridge Configuration
- 50. Bridge Configuration with Laggards
- 51. Bridge Configuration with Laggards

Photoplate - IX (52-60) : Showing different stages of  
meiosis in C. latifolium

- 52. Dikinesis
- 53. Bivalents
- 54. Mataphase-I-with laggard
- 55. Mataphase-I-normal
- 56. Anaphase-I-spindle apparatus
- 57. Meiocytes with less DNA content
- 58. Meiocytes with less DNA content
- 59. Anaphase - I
- 60. Telophase

Photoplate - X (61-69) : Showing different stages of  
meiosis in C. spp ( $2n = 44$  )

61. Mataphase
62. Metaphase with laggards
63. Early anaphase I with sticky chromosomes
64. Anaphase with laggards and chromosome bridges
65. Anaphase with laggards and chromosome bridges
66. Interphase II
67. Metaphase II
68. Telophase II
69. Tetrad stage



# PLATE - I





# PLATE - II



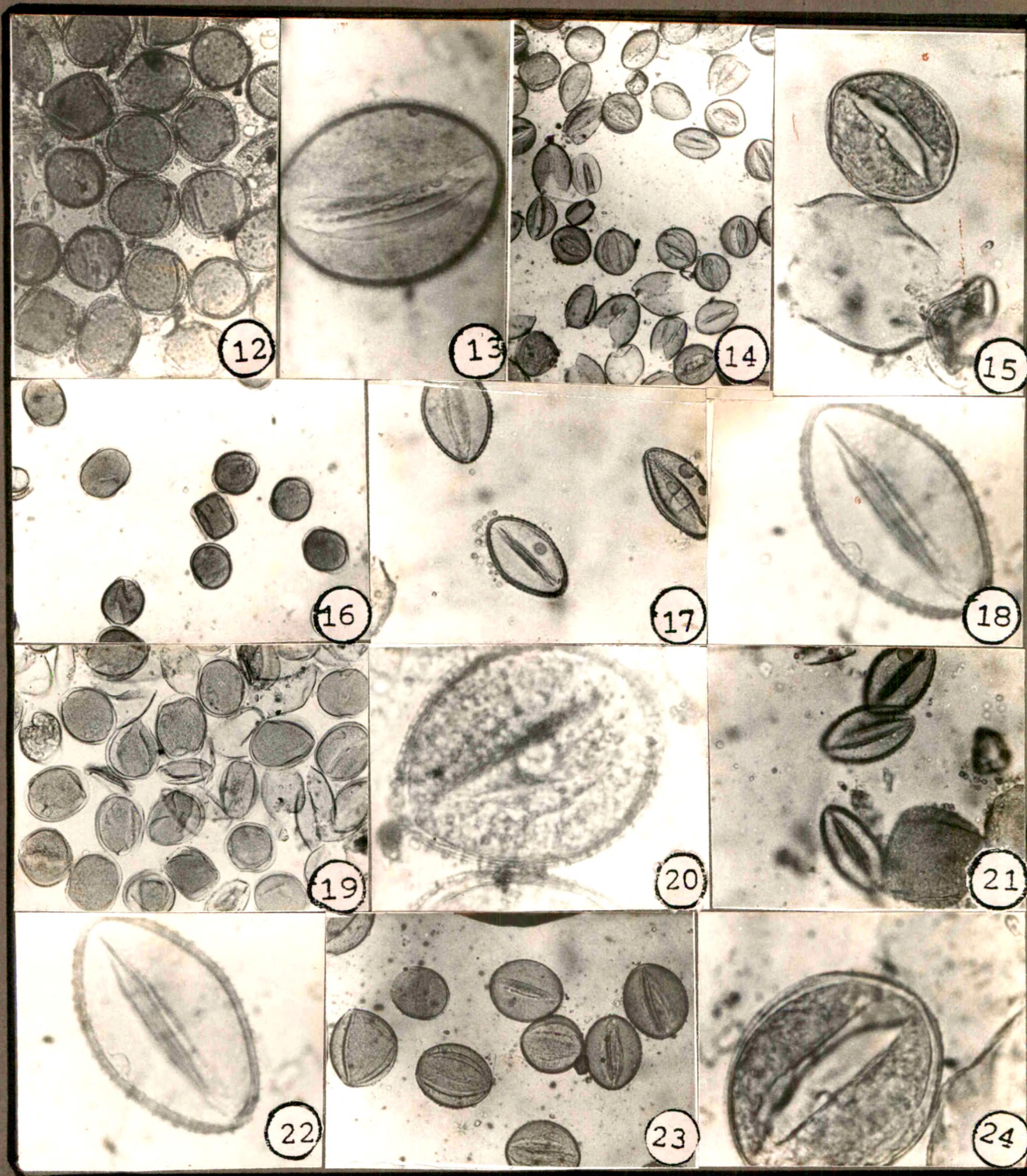


# PLATE - III



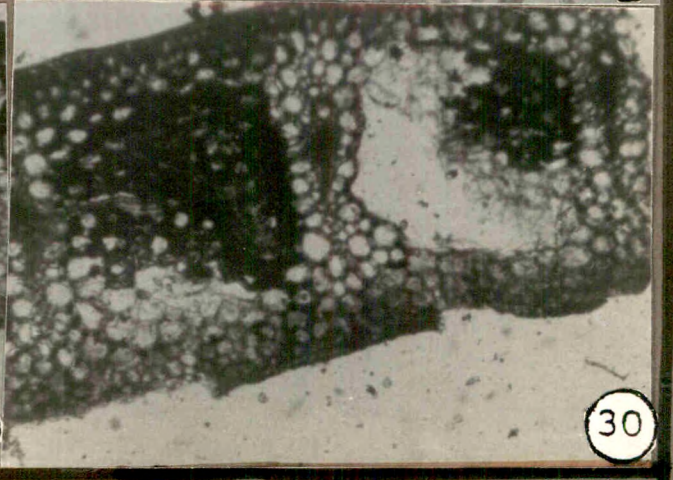
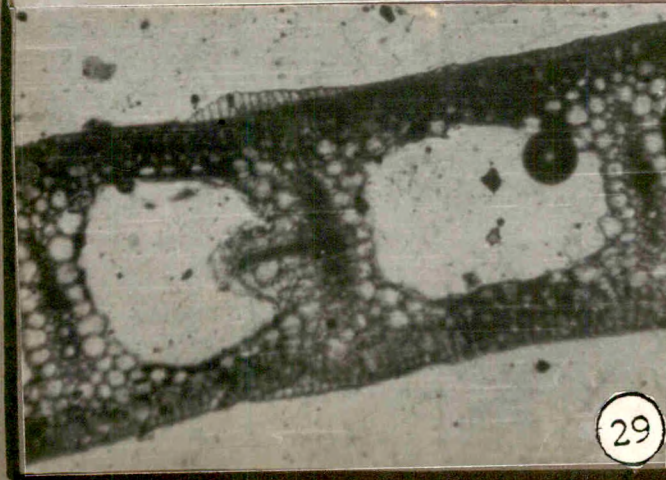
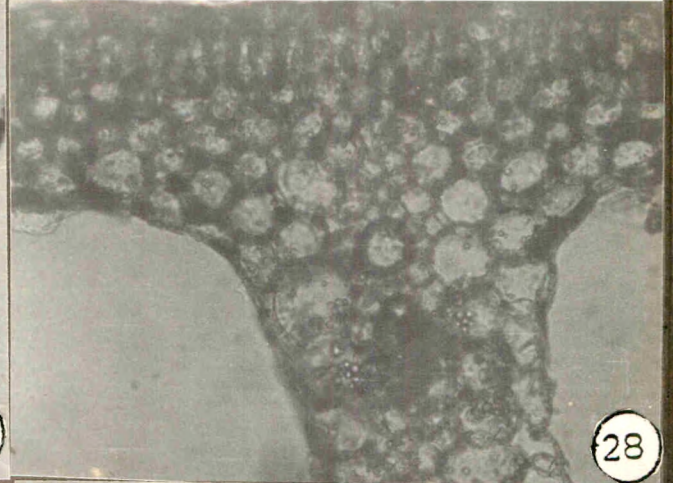
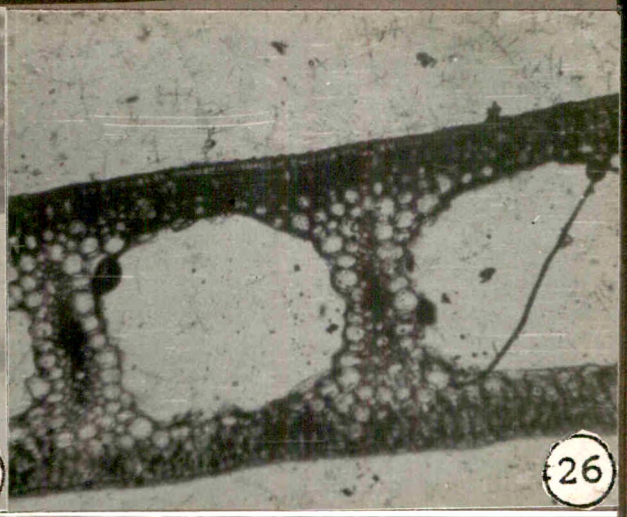
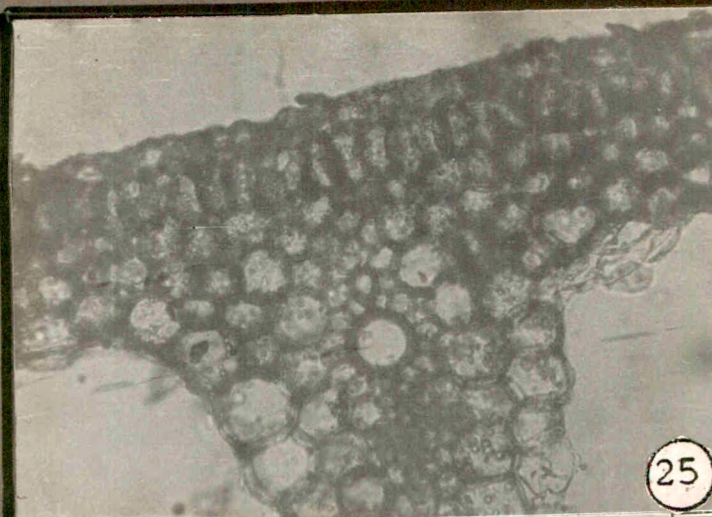


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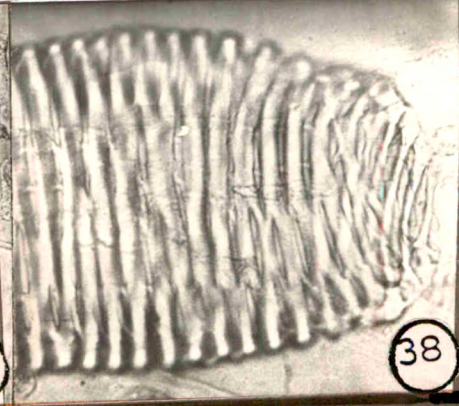
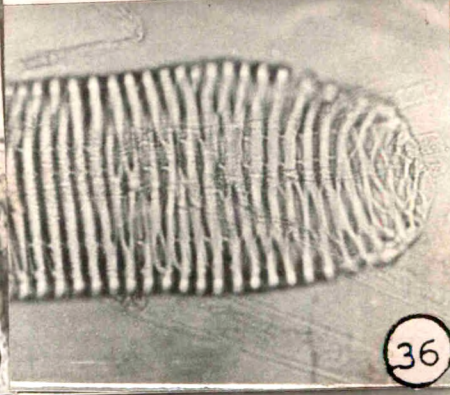
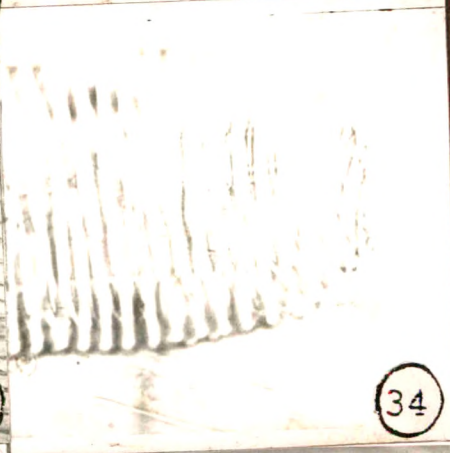
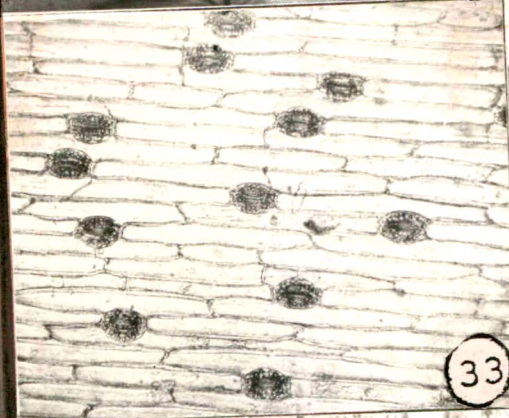
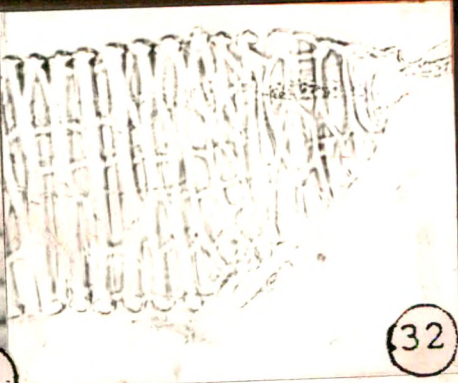
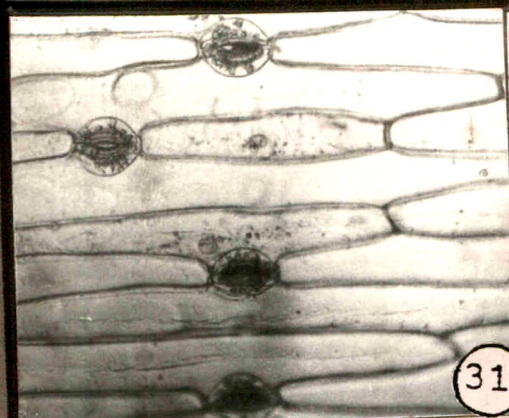


**PLATE - V**



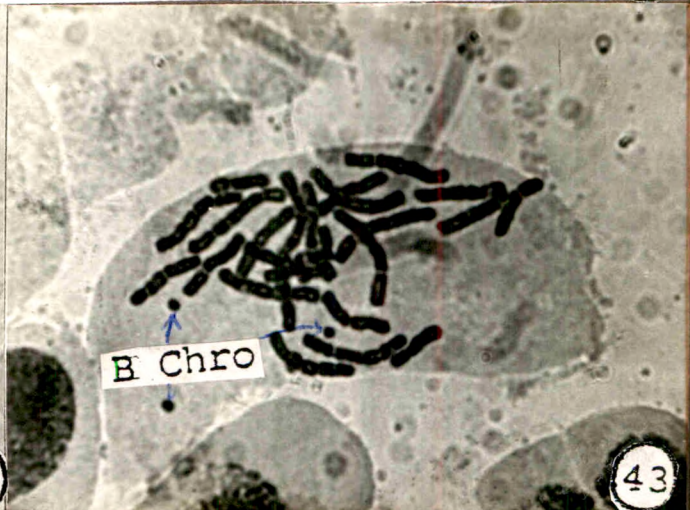
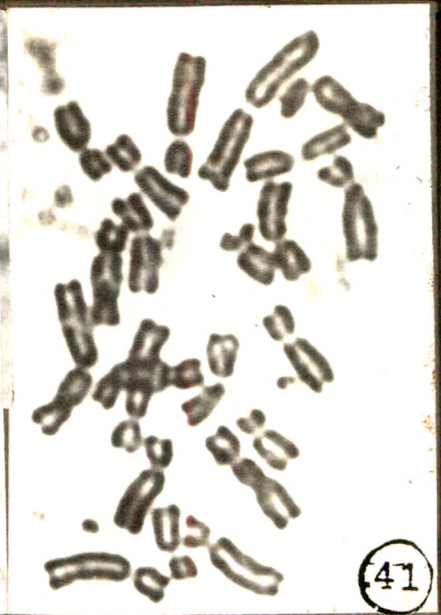


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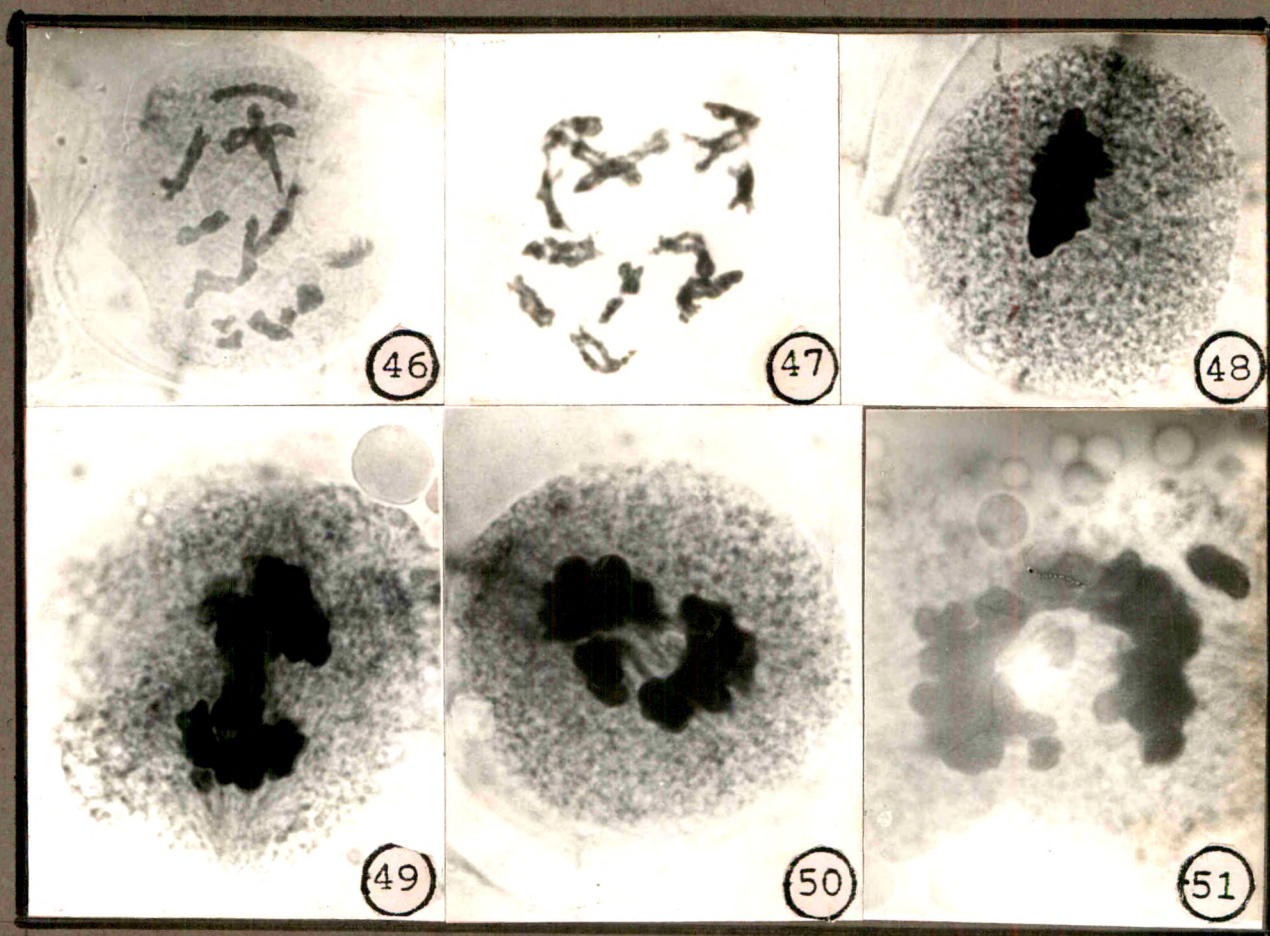


# PLATE - VII



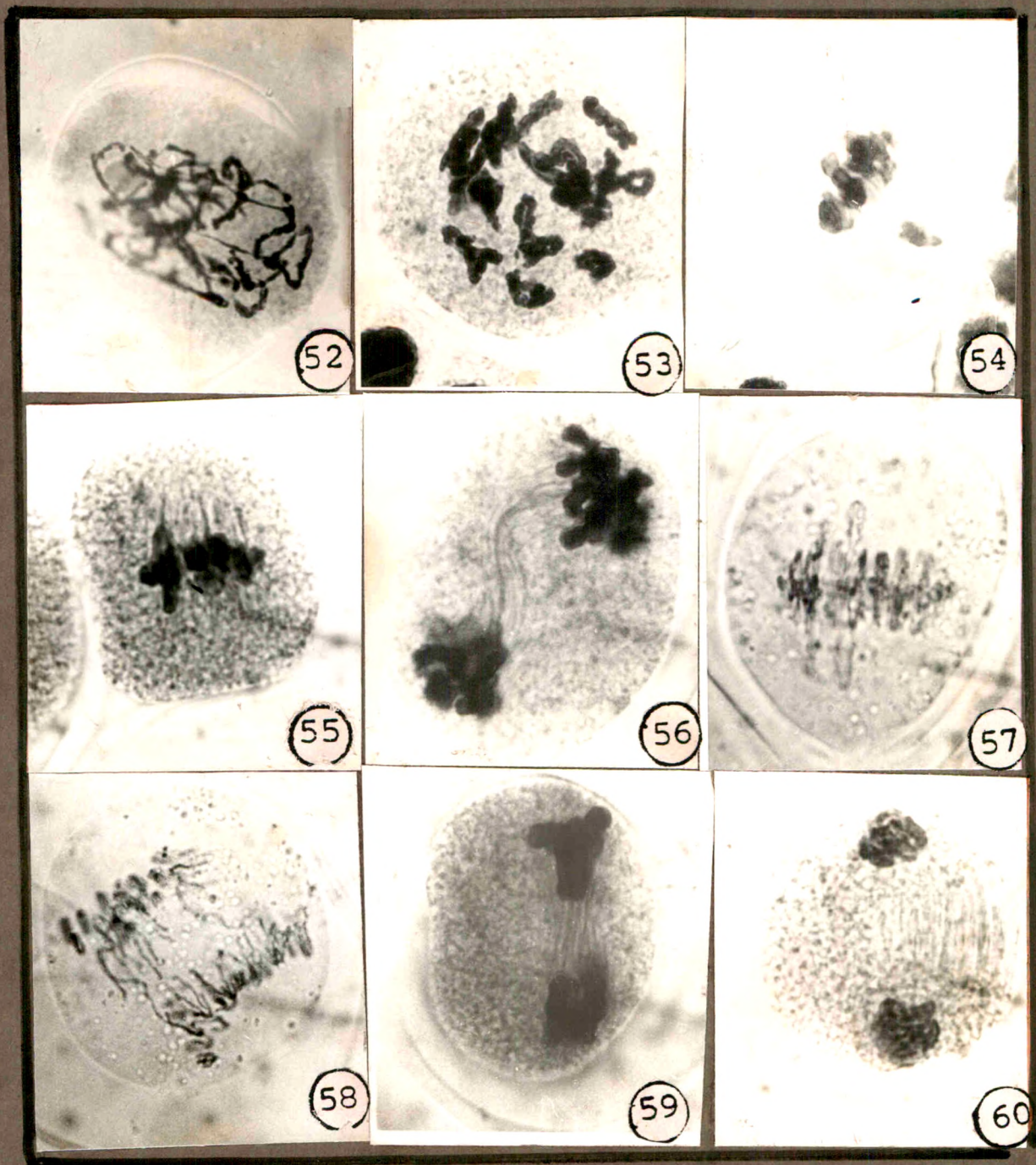


## PLATE - VIII



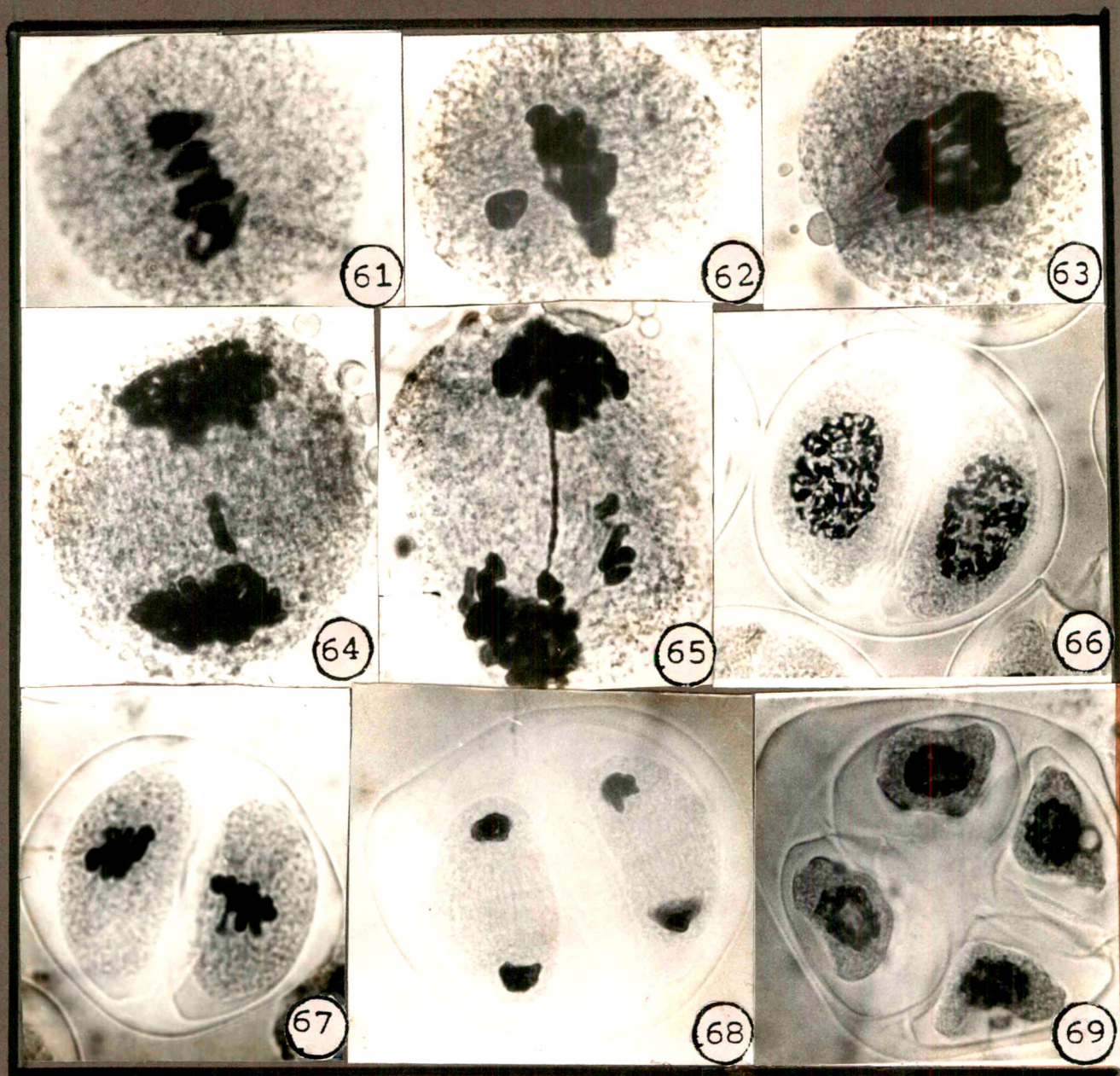


# PLATE - IX





# PLATE - X





Text Figure - I ( 1-8 )

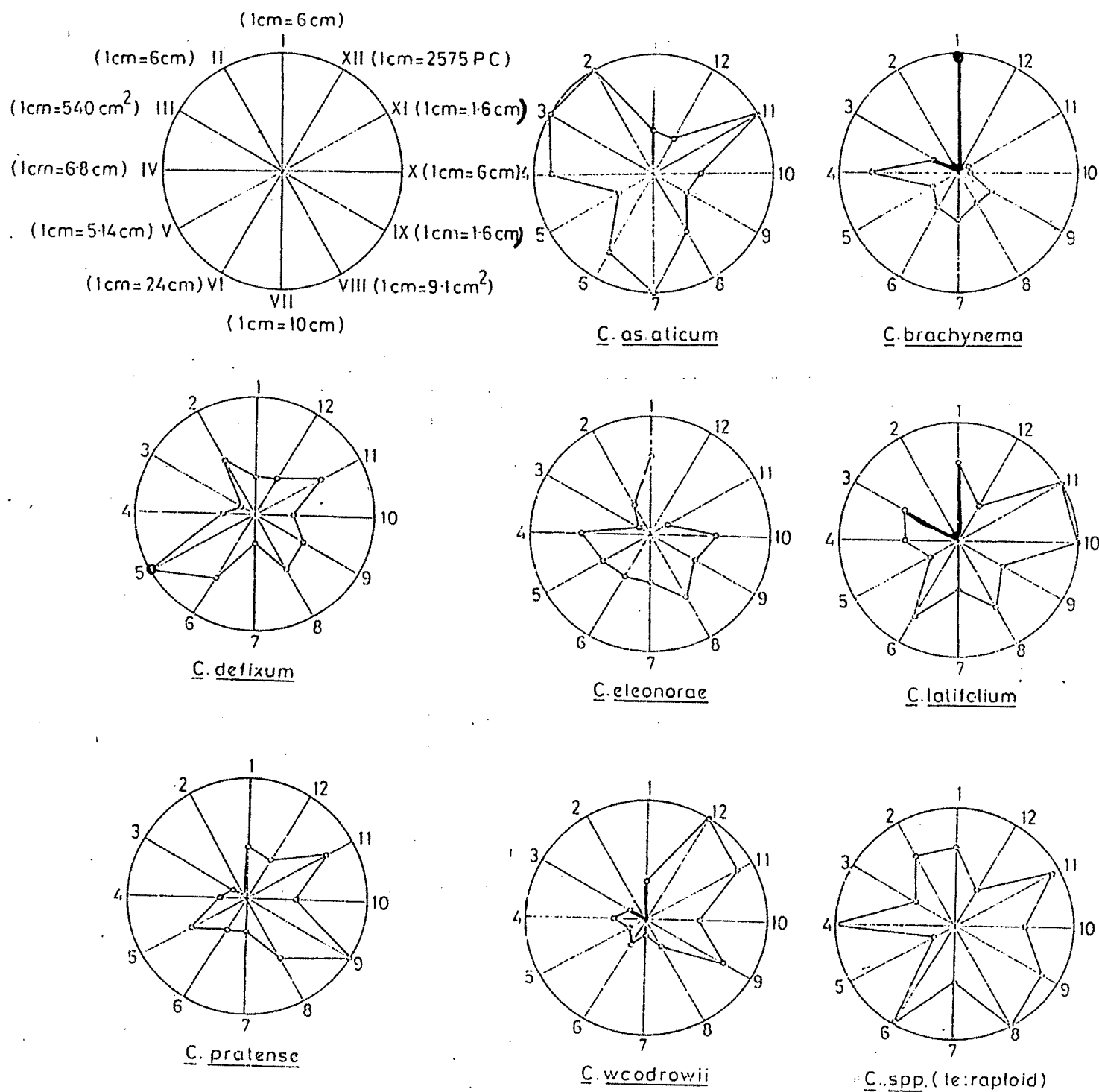
Showing key diagram to the polygraphys and polygraphs of  
wild and cultivated plants of different species of  
Crinum

Axis I to XII shows

- I. Diameter of bulb
- II. Neck Length
- III. Leaf length X Breadth
- IV. Leaves per plant
- V. Leaf length/Leaf Breadth
- VI. Scape Length
- VII. Flowers/Inflorescence
- VIII. Bract Length X Breadth
- IX. Pedicel Length X Breadth
- X. Petal length X Petal Breadth
- XI. Stamen filament length
- XII. Pollen Length X Breadth



# FIGURE I



Bombay III 256. 1958 (Table, 6, 7 and Fig.I, Photoplate I,1).

Bulbs globose, 5-10.5 cm in diameter, narrowed into a neck 10-30 cm long, clothed with old leaf sheaths; roots fleshy. Leaves 20-30 per bulb, glabrous, thick, 90-150 X 10-18 cm, linear lanceolate, shortly acuminate, flat, narrowed with sheathing base, bright green with smooth margins. Scape 45-90 cm long, 2.5 cm in diameter, flowers white, 15-50 in umbel; bracts 7-10 X 2-2.6 cm; Pedicel 0.6 -2.5 cm long. Perianth tube greenish-white, 7-10 cm long, cylindric, slender, perianth lobes 7-10 X 1-1.2 cm, linear, recurved or revolute. Stamens reddish, filaments slender, 6-8 cm long, anthers 1.2 -1.9 cm, versatile. Ovary three celled, green 1-2 X 0.5-0.6 cm, ovules many in each cell, style pink-purple, 12-15 cm long. Fruit subglobose, 2.5 -5cm in diameter, usually one seeded, beaked by fleshy base of the perianth, dehiscing irregularly.

Distribution - Maharashtra (Map 1)

It is usually found cultivated in Gardens for its foliage and fragrant flowers. Graham, Dalzal and Gibson have reported it from Konkan area, however, we have found it only under cultivation in Garden.

Vernacular Names -

SANS : Nagdamani, Nagapatra;

URDU : Nagadaman;

BENG	: Nagdaun;
HINDI	: Kanwal, Pindar;
GUJ	: Nagdamani;
MAR	: Nagdavana;
TEL	: Kesarchettu, Vishamungali;
KAN	: Vishamungali;
TAM	: Vishamungali;

#### Phenology -

Peak season of flowering is from May-July, however, flowering is seen throughout year under cultivation. The vegetative growth is seen throughout year if water is provided. Probably under cultivation the plant has lost the dormant phase and show active growth under favourable environment.

#### Economic And Medicinal Importance

Almost all species of Crinum have been put to several medicinal and economic uses. The bulbs are pungent, bitter, laxative, carminative, antipyretic; anthelmintic, emetic, useful in biliousness, strangury, snake bite, vomiting, urinary discharges, tumours, diseases of vagina, the abdomen and blood (Ayurveda). Bulbs are also said to be tonic, expectorant, aphrodisiac, useful in bronchitis and diseases of the chest and lungs, gonorrhea, night blindness and defective vision, diseases of the spleen. Urinary concretions, lumbago, anuria, toothache, badsmell of perspiration. The seeds are bitter, purgative, diuretic,

Table No. 6 : Comparative account of qualitative morphological characters of Crinum species of Maharashtra

Sr. No.	Morphological Character	Species						
		<u>C. asiaticum</u>	<u>C. brachynema</u>	<u>C. defixum</u>	<u>C. eleonorae</u>	<u>C. latifolium</u>	<u>C. pratense</u>	<u>C. woodrowii</u> <u>C. spp.</u> (tetraploid)
1.	Habitat	Mostly cultivated	Endemic on slopes of hills (Mahabaleshwar)	It grows along margins of falls or in river bed	Endemic, on slopes of Mahabaleshwar hills	Cultivated in gardens as well as wild	Grows on plateau, cultivated	Endemic on the slopes, hills (Mahabaleshwar)
2.	Leaf shape, texture and Leaf colour	Linear, lanceolate, Bright green	Lorate, Bright green	Narrowly linear, Bright green	Ensiform, broad, glabrous dark green	Lorate, Bright green	Narrowly linear Bright green	Broadly linear Bright green
3.	Leaf margin	Smooth	Smooth	Scaberulous	Smooth	Smooth	Scaberulous or Smooth	Smooth
4.	Corolla shape	Salver shaped, tube straight	Funnel shaped, nodding	Salver shaped, tube straight	Funnel shaped	Funnel shaped, tube curved	Salver shaped, tube straight	Salver shaped, tube straight
5.	Petal shape	Linear	Oblanceolate	Linear	Oblanceolate	Oblong lanceolate	Lanceolate	Lanceolate
6.	Pollen colour	Orange	Orange	Orange	Orange	White	Orange	Orange

Table No. 7 : Comparative account of quantitative morphological characters of Crinum species of Maharashtra

Sr. No.	Morphological Characters	S p e c i e s									Crinum spp. (Tetraploid)
		<u>Crinum asiaticum</u>	<u>Crinum brachyneura</u>	<u>Crinum defixum</u>	<u>Crinum eleonorae</u>	<u>Crinum latifolium</u>	<u>Crinum pratense</u>	<u>Crinum woodrowii</u>			
	Diameter of Bulb (cm)	5-10.5	25-30	5-10	15-20	12-20	10-13	9-10	15-20		
	Neck length (cm)	10.30	---	5-15	5-8	---	---	---	10-20		
	Leaf length (cm)	90-150	45-60	60-90	40-60	50-100	40-70	30-40	45-75		
	Leaf breadth (cm)	10-18	7-10	2-3.5	5-6	7-15	3-5	7-10	8-3.5		
	Leaf length X Breadth	2700	600	315	360	1500	350	400	1012		
	Leaf length X Breadth	8.33	6	27.7	10.0	6.7	14.0	4	5.5		
	Leaves/plant	20-30	15-25	6-9	15-20	10-15	6-8	5-10	25-34		
	Scape length (cm)	40-90	25-40	45-75	30-50	40-90	30-40	25-30	50-120		
	Pedicel length (cm)	0.6-2.5	1-1.4	---	1.0	---	1.5	2-2.5	0.9-1.2		
	Bract length (cm)	7-10	40-50	38-6	8-9	7-10	5-8	3-4	8-13		
	Bract Breadth (cm)	2-2.6	3-3.2	3-4	3.3-	2-3	2-3.5	2-3	2.8-3.5		
	Bract length X Breadth	26	14	24	28.7	30.0	28.0	12	45.5		
	Flower/Inflorescence	15-50	15-20	6-12	15-20	5-20	5-15	6-7	20-25		
	Flower length (cm)	7.1-10.4	4.0-5.1	6.4-7.8	5-6.5	8.1-14.0	7.6-10.3	7.5-9.1	8.1-11		
	Petal length (cm)	7-10	2-5	5-6	6-7.5	7-10	7-10	7-9	7.5-11.2		
	Petal Breadth (cm)	1-1.2	1.5-1.9	1.2-1.6	2-2.2	2.5-3	1-1.2	1-1.5	1-1.6		
	Petal length/Breadth	8.33	2.6	3.75	3.4	3.3	8.3	6	6.8		
	Petal length X Breadth	12.0	9.5	9.6	16.5	30.0	12.0	13.5	17.6		
	Stamen filament length(cm)	6-8	0.5-0.7	4-5	1	5-8	4-6	5-7	4.5-7.4		
	Pollen ( L X B )	4556	---	4544	---	4556	4824	12862	4087		

emenagogue, tonic, useful in diseases of the kidney and in furfurculosis (Yanani). Roots are emetic in small doses nauseant and diaphoretic. The leaves are applied to the skin diseases, braised and mixed with castor oil, juice of the leaves is used in earache. the decoction of the leaves is used as an expectorent (Kirtikar and Basu 1984).

It is a commonly grown ornamental plant for its bright green lorate leaves and fragrant long white flowers.

2. Crinum brachynema Herb. in Bot. mag. Misc. 36. 1842.  
Hook. f. fL. Brit. India 6 : 284. 1892. Cooke T. Fl.  
Pres. Bombay III 258. 1958. (Table 6,7, Fig.I, Photoplate I, 2).

A bulbous perennial herb, bulb ovoid 10-15 cm in height, 25-30 cm in diameter without distinct neck, roots fleshy. Leaves developed only after flowering, lorate, bright green with entire margin, 45-60 X 7-10 cm. Scape solitary, 25-40.5 cm in height, subterete. Inflorescence umbel, 15-20 flowered, bracts 2, lanceolate 3-5 cm long, greenish-white. Flowers fragrant, perianth tube not much curved, greenish, 3-5 cm long; perianth lobes 2-5 X 1.5 X 1.9 cm, pure white, oblanceolate, obtuse, cuspidate. Stamens 6, 0.5 to 0.7 cm long, very short than perianth lobe; anthers 0.5 cm in length, yellow. Ovary 3-celled, style filiform, included in the perianth tube. Fruit 1-2 cm in diameter, few seeded seeds green.

### Distribution - Maharashtra (Map 1)

It grows on hill slopes around Mahabaleshwar. It is reported to be very common in the open jungle (Cooke 1958) of Mahabaleshwar hills, however, due to indiscriminate exploitation and sale of bulbs in Mahabaleshwar market, it has become very rare. It is in endangered state and needs attention for its conservation.

### Phenology

Species starts flowering by May and continues up to June. Scapes appear in month of May as soon as the mist comes on the hills before rains. It produces leaves only after flowering. Vegetative growth continues up to September-October. By the end of October the aerial leaves dry and plants go to sleep from November to April.

### Ecological Note

It is an endangered endemic plant of India restricted to few patches on hill slopes around Mahabaleshwar. There is need for its conservation in-situ and ex-situ.

### Economic Importance

In month of May, scapes with long white flowers along with bulbs are sold in Mahabaleshwar Market. It has definite ornamental value as other Crinum species. No other work has been done on the species and we do not know potential of the species from medicinal point of view. It is a very interesting species having shortest stamen

filament length in Indian species. It is of botanical interest.

3. Crinum defixum Ker. Gawl. in J. Sci. Arts. London 3 : 105. 1817; Hook f, Fl. Brit. India 6 : 281. 1892 Cooke T. Fl. Pres. Bombay III 257, 1958 (Table 6.7, Fig.I, Photoplate I, 314).

A bulbous, perennial scapigerous herb; bulbs ovoid 5-8 cm in diameter, 8-9 cm in height; neck 5-15 cm long, cylindric. Leaves 6-9 per bulb, 60-90 X 2-3.5 cm, linear, deeply channelled down the face, obtuse or acute, concave, thick dark green with slightly rough margin. Scape solitary from the axils of the lowest leaves, 45-75 cm in length, erect, cylindric, bracts 2, oblong lanceolate, subacute, 3.8-6 X 3.4 cm, bracteoles filiform. Flowers white, umbels 6-12 flowered, flowers white, 12-20 cm long; pedicels very short; perianth tube 6-7.5 cm long, slender cylindric; perianth lobes 5-6 X 1.2-1.6 cm long, narrowly linear, stamen 6; filaments 4.5 cm long, bright red, filiform, anthers 1-1.5 cm long; pollens orange ovary 1.5 cm long, green, triloculed with 4-5 ovules per locule; style 16 cm long, declinate; stigma simple. Fruit subglobose, 2-6 cm in diameter, shortly pedicelled, beaked by perianth tube, few seeded; seeds 1-3 cm in diameter, rugose.

Distribution - Maharashtra (Map 1)

It is widely distributed throughout India. It is



found growing in river-beds, ponds, lakes and similar aquatic habitats. It is collected from Masai plateau near Panhala, Belgaum and Konkan.

#### Vernacular Name

SANS : Vishamandala,  
 BENG : Sukdarshan,  
 GUJ : Nagrikand,  
 TEL : Kesarchettu,  
 MADRAS : Vishamungil,  
 MAR : Vishamandal.

#### Phenology

The species start sprouting with on set of monsoon and shows peak blooming during July-August. By the end of October as ponds dry the aerial parts dry and bulbs go to dormancy period from November to May.

#### Economic And Medicinal Importance

Kirtikar and Basu (1984) give following medicinal uses of the species.

The bulbs of C. defixum is emollient and emetic, in small doses it is a nauseant and diaphoretic. The bulb and stolon are very much used in madagascar, both internally and externally for treatment of burns, whitlow and carbuncle. In otitis a few drops of the juice of the leaves are inserted into the ear. Wealth of India (1950)

reports bulbs as toxic to cattle. The bulbs are cut from the base and are warmed in mustard oil, and applied to injured and inflamed portion of the body to relieve pain by the tribals of Varanasi, Dist. U.P. (Singh and Maheshwari, 1983). In addition to medicinal value, it has ornamental value and could be used in lakes and water bodies.

4. Crinum eleonora Blatt and McCann. in J. Bombay nat. Hist. Soc. 32 : 733. 1928 (Table. 6,7, Fig.I).

Bulb ovoid or almost spherical, upto 20 X 13 cm, narrowed into a stout neck about 8 cm long, clothed with old pale leaf sheaths. Leaves appearing after the flowers, ensiform with obtuse apex upto 60 cm long and 5 cm broad, not very firm, fairly thin, dark green, glabrous with the margin entire. Scape lateral, upto 50 cm long, reaching 2.5 cm diameter, cylindrical, but slightly compressed, green, tinged with purple. Flowers white, strongly scented, upto 20 in an umbel, nodding. Bracts-2, broadly lanceolate, obtuse or acute with broadly inflexed and thickened margin, 9 X 3.3 cm, green tinged with purple outside, pale inside. Bracteoles linear, upto 9 cm long, stout. Perianth funnel-shaped, tube green, tinged with purple, or greenish and becoming paler towards tip, upto 6.5 cm long, cylindric at base, then becoming 4 sided with rounded angles, lobes upto 7.5 cm long and 2.2 cm broad, lanceolate the inner ones sometimes oblanceolate, cuspidate, reflexed and slightly concave at the tip with a longer cusp

in bud, pure white, sometimes tinged with purple along the median line on the back; the buds are cream coloured and the purple tinge is more pronounced. Filaments on the throat of the perianth tube free, filiform, 1 cm long; anthers in young buds, then getting black and only yellow along the open slits, dorsifixed upto 15 mm long, oblong, twisted when dry. Style filiform, included in the tube, upto 5 cm long, white in lower part, purple above; fruit not seen.

Distribution - Maharashtra (Map 1)

Lingmala near Mahabaleshwar, open hill-sides and on both sides of the river above the Yenna falls, half way between Panchgani and Mahabaleshwar.

Flowering

End of April and begining of May.

Fieldnote And Economic Importance

Even after careful search for the species in its type locality, it could not be located. Several field trips were made to Mahabaleshwar during May to August for last 3 consecative years, however, worker failed to collect the species. Probably the species have become extinct or is confused with C. brachynema, a closely related species.

The flowers are fragrant and we do not know about it's potential value from medicinal point of view, of course all the Crinum species have ornamental value. C. brachynema and C. eleonora could be a good addition

to horticultural trade as an ornamental plant.

5. Crinum latifolium Linn. Sp. pl. 291. 1953. Hook f. Fl. Brit. India 6 : 283, 1892. Cooke. T. Fl. Pres. Bombay III. 258, 1958 (Table 6,7, Fig.I; Photoplate II, 5,6).

Perennial herbs with large, subglobose tunicated bulbs; bulbs 12-20 cm in diameter, 8 cm in height; neck short, 2 cm long, stout, basal rooting disc 6 cm in diameter. Leaves numerous, 10-15 per bulb, appearing almost with flowers or little latter, 50-100 cm X 7-15 cm, lorate, acuminate, bright-green with almost smooth margin. Scape stout, usually one per bulb, 40 to 90 cm long, 3-4 cm in diameter, tinged with purple or green. Flowers 5-20 per umbel, fragrant, white or tinged with pink, bracts 7-10 X 2-3 cm; oblong lanceolate; pedicels short, 0.5-1.3 cm long, flower 10-20 cm long, curved cylindric. Perianth tube 7-10 cm long. Perianth lobes 7-10 X 2.5-3 cm, oblong, lanceolate acute. Stamens 6; declinate, 5-8 cm long, white, anthers 1-2 cm long, gray, pollen gray. Ovary 1-1.3 cm long, 3-celled, with 5-6 ovules per locule. Style 10-11 cm long, red. Fruit subglobose, 3-5 cm in diameter, 5-10 seeded, seeds globose to subglobose, 0.5-1 cm in diameter green.

Distribution - Maharashtra (Map 1)

It grows wild as well as cultivated in many gardens as ornamental herb. It is reported from South-Konkan, Lanoli and Panchgani plateau. It is also collected

from Ratnagiri, Gaganbavada and Ramghat.

#### Vernacular Names

SANS : Madhuparnika, Vrishakarni;  
BENG : Sukhdarsan,  
TAM : Vishamungil,  
BOMBAY : Gadambikanda.

#### Phenology

The plants of the species flower during April to June and simultaneously leaves are developed by June. It shows vegetative growth during June to September. By the end of September the aerial parts dry; and it perpetuates the dry season in form of under ground bulbs.

#### Economic and Medicinal Importance

Kirtikar and Basu (1984) gives following medicinal importance of the species.

The bulbs of C. latifolium is fragrant and heating, used in 'Vata', bronchitis and inflammation (Ayurveda). It is extremely acrid and is used for blistering cattle, a slice being bound up on the skin. Roasted bulbs are used as a rubefacient in rheumatism and applied to piles and abscesses to cause suppuration. Leaf juice is used in earache.

Also commonly cultivated as an ornamental plant in the garden for their bright green leaves and elegant showy flowers.

6. Crinum pratense Herb. Amaryllid, 256, 1837, Hook f. Fl. Brit. India, 6 : 282 1892. Cooke T. Fl. Pres. Bombay III 257. 1958 (Table 6,7; Fig.I, Photoplate II, 7,8).

Scapigerous, perennial herb; bulbs ovoid, tunicated, 10-13 cm in diameter, 7-9 cm in length, with short neck, 5-6 cm long, rooting disc 1-1.5 cm in diameter. Leaves 6 to 8 per bulb, 40-70 X 2-5 cm, linear, suberect, entire or ciliolate on margin, apex acute. Scapes lateral, usually one per bulb, compressed, 30-40 cm long and 1-2 cm in diameter. Umbels 5-15 flowered, bracts large 5-8 X 2-3.5 cm, ovate-deltoid, acute; flowers sessile, 13-17 cm long; perianth tube 7-10 cm long, green, slightly curved; perianth lobes white or tinged with pink, 7-10 X 1-1.2 cm. Stamens 6, filament 4-6 cm long, bright red, pollen orange. Ovary stalked, stalk 1-1.5 cm long; ovary 1 to 2 cm long, green, triloculed with 3-4 ovules per locule, style long, filiform, red, 13-15 cm long; fruit subglobose, 4-5 cm in diameter; seeds few, round, 1 cm in diameter, green.

Distribution - (Maharashtra (Map 1))

It is widely distributed throughout India. It is found growing mostly on plateaus of Sahyadris. It grows along ponds, -lakes and prefers aquatic low lying rocky areas. It is collected from Kas, Barki, and Murjai plateaus, Malvan and Belgaum.

### Vernacular Names

### Phenology

With onset of monsoon the plants produce long leaves followed by appearance of scapes in month of May-July. The plants show vegetative growth during rainy season and leaves start dieing by end of September and bulb go to dormancy.

### Economic And Medicinal Uses

Commonly called as Lily; which has more or less honourable history as ornamental plant.

The extract of the bulbs of C. pratense is used in popular medicine as a bitter tonic and luxative and in chest ailment (Ghosal et al. 1981).

7. Crinum woodrowii Baker in Bot. Mag. t. 7597. 1898, Cooke T. Fl. Pres. Bombay III 257. 1958 (Table, 6,7, Fig.I).

Scapigerous perennial herb with tunicated bulbs; bulbs globose, 9-10 cm in diameter and 8-9 cm in length, neck absent. Leaves short, 30-40 X 7-10 cm, 5-10 per bulb, broadly linear, obtuse, glabrous, bright green, margin smooth. Scape lateral, stout, compressed, 25-30 cm long; umbels 6-7 flowered; bracts 3-4 X 2-3 cm, ovate, acute; flowers pedicillate; pedicels 2-2.5 cm long. Flower 15-18 cm long; perianth tube 7-9 cm long, cylindric, greenish,

perianth lobes white; 7-9 X 1-1.5 cm, lanceolate, spreading. Stamens 6, filaments bright red, 5-7 cm long, anther 0.7-0.9 cm long, linear, yellow. Ovary stalked, stalk 2-2.5 cm long, ovary 1-2 cm long, green three loculed with 4-6 ovules per locule. Style red, 7-9 cm long. Fruit 3-4 cm in diameter, 10-15 seeded, seeds 1-2 cm in diameter, green.

Distribution - Maharashtra (Map 1)

So far it is known only from type locality. It grows in same localities as that of C. brachynema and C. eleonora. It grows on slopes and flat hill-tops around Mahabaleshwar.

Phenology

The species flowers during May-June. Vegetative growth is observed throughout rainy season. As winter starts the aerial parts die off and bulbs go in dormancy.

Economic And Medicinal Importance

The species could be good addition as an ornamental plant. Other potential of the species is still to be exploited.

8. Crinum species (2n=44) (Table 6,7, Fig.I; Photoplate III, 9-10).

Scapigrous, perennial herbs with tunicated bulbs; bulbs globose, 15-20 cm in diameter, narrowed into 10-20 cm



long neck; root fibrous, fleshy; rooting disc 2-2.6 cm in diameter. Leaves 25 to 34 per bulb, glaucous, thick, 45-75 X 8-13.5 cm; linear, lanceolate, shortly acute; leaf margin smooth; hyaline. Scape 1 to 2 per bulb, 50-120 X 2-3 cm, green to pink, somewhat compressed. Umbels 20-25 flowered; bracts 2, 3-13 X 2.8-3.5 cm, appendages (bracteoles) among flowers 15-20 in number, 7-10 cm long, flowers white pedicellate, pedicel 1.4-2.8 X 0.3-0.4 cm; perianth tube greenish pink, 8-11 X 0.4-0.6 cm; Perianth lobe 7.5-11.2 X 1.0-1.6 cm, linear or narrowly lanceolate, recurved. Stamens 6, filaments 4.5-7.4 cm long, reddish, anthers 1-1.3 cm long dark purple, pollen orange-brown ovary 1.8-2.2 X 0.6-0.7 cm, green, 3-loculed with few ovules on axile placenta; style 11-14 cm long, filiform, red, stigma minute, simple fruit sub-globose, 4-5 cm in diameter, 10 to 20 seeded; seeds irregularly subglobose, 2-3 X 2.5-3 cm, smooth, green.

#### Distribution - Maharashtra (Map 1)

It is distributed along the western ghats. It grows on hilly-slopes in forest areas. It has been collected from Ghat-areas of Kas (Munawale), Radhanagari, Fonda ghat, Chandoli and Ramghat.

#### Phenology

The species shows peak blooming during May to June and leaves appear almost with scapes or little latter. The species shows vegetative growth in rainy season and by

the end of rainy season (September) the aerial parts dry and bulbs remain dormant in soil until next May.

#### Economic And Medicinal Importance

The species has dark green glaucous, large leaves and beautiful white flowers. It is very ornamental in vegetative as well as reproductive stage. It has great ornamental value other potential values have to be studied.

#### Pollination in Crinum

All the species of Crinum growing in Maharashtra are night-blooming. The flower buds going to open on a day, bent down from umbel while remaining buds stand erect in an inflorescence. Anthesis takes place in bent flower-buds during day time between 2-4 pm. Perianth lobes start opening by 5 pm and open fully around 7 pm. The flowers remain open throughout night. The perianth lobes close by next morning at about 6-7 am. The perianth tube is filled with nectar upto the mouth of perianth.

Pollination was observed in cultivated plants. Night flying moths with very long proboscis (5-6 cm long) (Photoplate III, 11) pollinate the flowers. The moth visits the flowers during 9-10 pm and tries to suck the nectar. While fluttering in front of flower, the pollens are dusted on hairy body of the moth. The bent style comes in contact with moth body and get pollinated. Crinum species have night blooming flowers pollinated by moth. After

pollination the perianth start drying and the basal portion of perianth tube persist and form beak on fruit.

✓  
Key to the Species of Crinum Species Occuring in Maharashtra

Identification of Crinum species goes difficult as there are no good taxonomic characters. Most of the characters are of quantitative nature. Over-lapping of these characters make it difficult to identify and delimit the species. Therefore, an improved key with reliable characters is presented here.

KEY TO THE IDENTIFICATION OF CRINUM SPECIES OF MAHARASHTRA

1. Leaves less than or upto 5 cm broad, leaf length-breadth ratio (L/B) 14-25, leaf length X Breadth (LXB) upto 350  
leaf usually with rough margin, plants usually of marshy places.
  2. Leaf 2-3.5 cm broad, leaf (LXB) 120-315, leaf (L/B) 25-30, scape length 40-75 cm,  
Petal linear, 5-6X1.2-1.6 cm, Petal (LXB) 6-9.6, Petal (L/B) 3-4.8
    1. C. defixum
  2. Leaf 3-5 cm broad, leaf (LXB) 120-350, leaf (L/B) 13-14, scape length 30-40 cm, Petal  
lanceolate, 7-10 X 1-1.2 cm, Petal (LXB) 7-12, Petal (L/B) 7-8.3
    2. C. pratense
1. Leaves more than 5 cm broad, leaf length-breadth ratio (L/B) 5-12, leaf length X Breadth (LXB) more than 350, leaf  
usually with smooth margin, plants usually not of marshy places.
  3. Stamen filament length 0.5-1 cm.
    4. Leaves 7-10 cm broad, leaf (L/B) Ca6, Petal 2-5X1.5-1.9 cm, Petal (LXB) Ca9.5,  
stamen filament 0.5-0.7 cm long
    4. Leaves 5-6 cm broad, leaf (L/B) Ca12, Petal 6-1.5X2-2.2, Petal (LXB) Ca16,  
stamen filament 1 cm long
      3. C. brachynema
      4. C. eleanora
  3. Stamen filament more than 3 cm long.
    5. Perianth funnel shaped, tube curved, perianth lobes oblong-lanceolate, Petal  
(LXB) 30, Petal (L/B) 3.3, Stamens declinate, pollens whitish gray
      5. C. latifolium
    5. Perianth salver-shaped, tube erect, perianth lobes lanceolate-linear, Petal (LXB)  
12-18, Petal (L/B) 45-12, stamens long, spreading not declinate pollen orange
      6. Leaves 5-10 per plant, leaves 30-40X7-10 cm, leaf (LXB) 450, leaf (L/B) 4,  
scap length 25-30 cm, flowers/inflorescence 6-7, Pollen (LXB) 12862 u
      6. Leaves 20-35 per plant, leaves 45-150X10-20 cm, leaf (LXB) 1000-2700, leaf (L/B)  
5.5-8.3, scape 45-120 cm long, flowers/inflorescence 15-50, Pollen (LXB)  
4000-4600 u
        6. C. woodrowii
  7. Leaves bright green, not glaucous, bulb 10-15 cm in diameter Petal (LXB)  
12, usually cultivated.
    7. C. asiaticum
  7. Leaves bright green, glaucous, bulbs 15-20 cm in diameter, Petal (LXB)  
17.6, wild
    8. C. species

### Palynology

A comparative study of pollen with reference to size, shape, size-frequency classes, and pollen fertility of Crinum species have been investigated. The pollen grains of Crinum do not show much variations, in morphology. They are elliptic, dizonocolpate and echinulate. They are shed in two-celled condition. The comparative account of pollen characters of the species is given in table 8. The size frequency classes are shown graphically in Text Fig.II.

1. Crinum asiaticum (2n=22) (Table 8, Fig.II,3, Photoplate-IV, 12-13).

Pollen grains are orange-brown in colour, elliptic, dizonocolpate, microreticulate with echinulate sculpture. Unhydrated pollen ranged in size from 50-86 X 46-86 averaging to 68 X 67  $\mu$ . Acetolized pollen ranged in size from 68-109 X 50-91  $\mu$ , averaging to 87 X 72  $\mu$ . Frequency size class with pollen size 66-88 was found to be dominating followed by 50-65 class. Pollen fertility was found to 93 percent and pollens are shed in two celled condition.

2. Crinum defixum (2n=22) (Table 8, Fig. II, 4, Photoplate- IV, 14-15).

Pollen grains are orange-brown in colour, elliptic dizonocolpate, microreticulate, echinulate. Unhydrated pollen ranged in size from 50-86 X 49-81  $\mu$  averaging to 71 X 64  $\mu$ . Acetolyzed pollen ranged in size from 68-90 X 54-81  $\mu$

averaging to 78 X 69  $\mu$ . Pollens with 66-80  $\mu$  in size formed the dominant size frequency class, pollen fertility was found to as high as 95% and grains are shed in 2-celled condition.

3. Crinum latifolium (2n=22) (Table 8, Fig.II,1 Photoplate-IV, 16).

The pollen colour of this species differs from all other species under study. The pollen are white-gray in colour, elliptic in shape, dizonocolpate, microreticulate with echinulate sculpturing. Unhydrated pollen ranged in size from 50-104 X 49-90 $\mu$  averaging to 68 X 67  $\mu$ . Similarly acetolyzed pollen ranged in size from 59-90 X 54-81  $\mu$ ; averaging to 75 X 65  $\mu$ . Pollen with 66-80  $\mu$  in size was found to be dominant size frequency class (Text Fig.II Pollen fertility was as high as 94% and pollens are shed in 2-celled condition.

4. Crinum pratense (2n=22) (Table 8, Fig.II, 2, Photoplate-IV,17-18).

The pollen are orange in colour, elliptic in shape, dizonocolpate, microreticulate and echinulate. Unhydrated pollen ranged in size from 50-104 X 49-90  $\mu$  averaging to 72 X 67  $\mu$ . Acetolysed pollen ranged in size from 72-99 X 50-86  $\mu$  averaging to 84 X 67  $\mu$ . Size frequency class of 66-80  $\mu$  dominated in the pollen (Text Fig.II. Pollen fertility was found to be 90% and pollens are shed in 2-celled condition.

Table No. 8 : Showing comparative account of pollen characters of Crinum spp.

Sr. No.	Palynological Characters	<u>Crinum asiaticum</u>	<u>C. defixum</u>	<u>C. latifolium</u>	<u>C. pratense</u>	<u>C. woodii</u>	<u>C. spp.</u>	<u>C. spp.</u>
1.	<u>Cytological status</u>	2n=22	2n=22	2n=22	2n=22	2n=22	2n=33	2n=44
2.	Ornamentation	Microreticulate	Microreticulate	Microreticulate	Microreticulate	Microreticulate	Microreticulate	Reticulate
3.	Size of Unhydrated Pollens	50 X 49 -86 X 86	50 X 49 -86 X 81	50 X 49 -104 X 90	54 X 49 -104 X 90	81 X 77 -118 X 109	63 X 54 -99 X 90	54 X 49 -100 X 77
	ii) Average (u)	68 X 67	71 X 64	69 X 67	72 X 67	100 X 93	95 X 70	67 X 61
4.	Size of Acetolysed Pollens	68 X 30 -109 X 91	63 X 54 -90 X 81	59 X 54 -90 X 81	72 X 50 -99 X 86	81 X 68 -131 X 122	63 X 45 -99 X 86	63 X 36 -100 X 86
	ii) Average (u)	87 X 72	78 X 69	75 X 65	84 X 67	103 X 89	83 X 68	80 X 71
5.	Pollen condition at the time of shedding	Usually 2-celled	2-celled	2-celled	2-celled	2-celled	2-celled	2-celled
6.	Size frequency classes (u)	32%	21%	24%	23%	---	2%	41%
	A - (50 - 65)					---		
	B - (66 - 80)	64%	60%	62%	60%	---	27%	50%
	C - (81 - 95)	4%	19%	12%	16%	42%	60%	7%
	D - (96 - 110)	---	---	2%	1%	41%	11%	2%
	E - (111-125)	---	---	---	---	17%	---	---
7.	Pollen fertility	93%	95%	94%	90%	95%	60%	92%

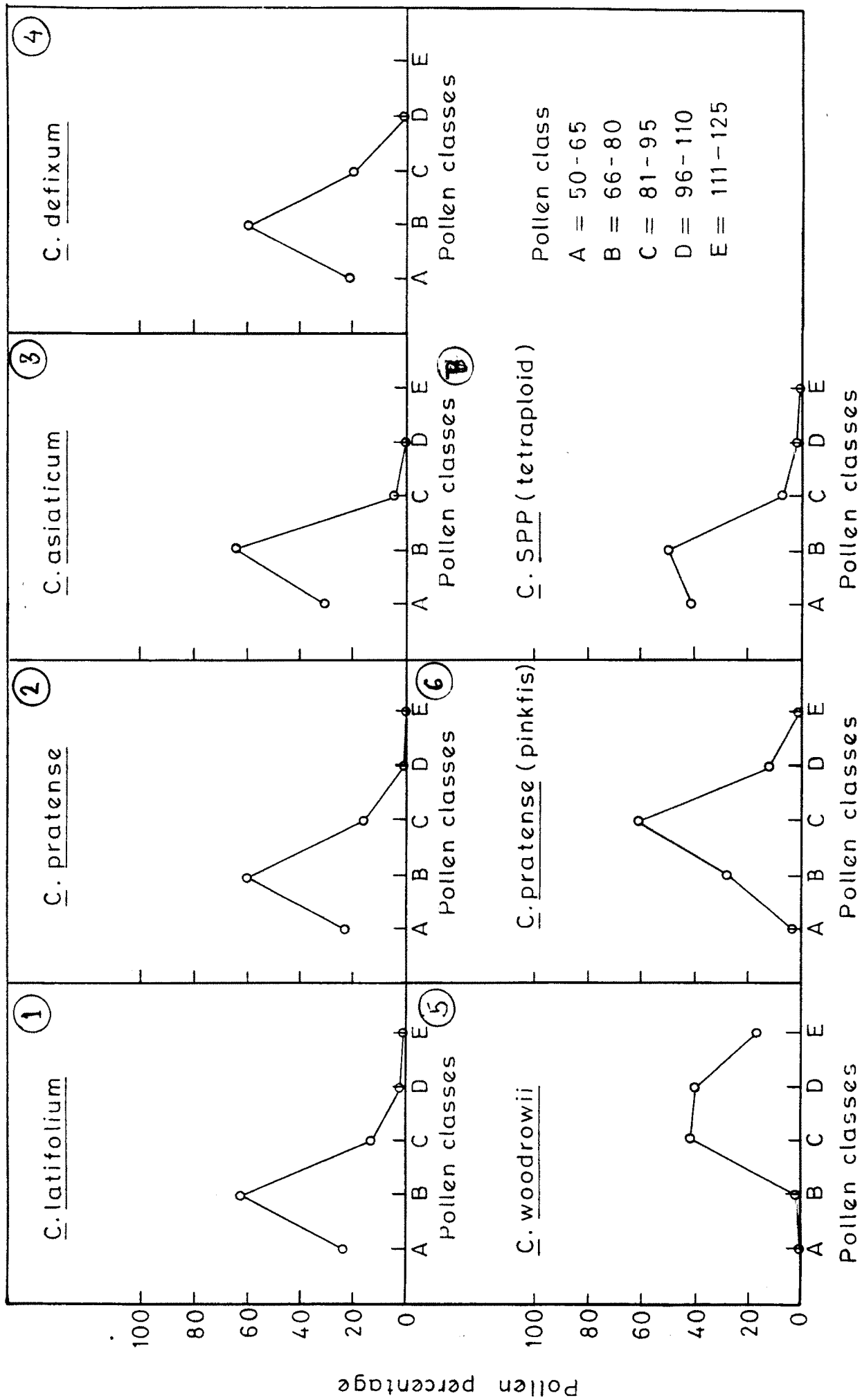


Fig. 11 SHOWING COMPARATIVE ACCOUNT OF SIZE FREQUENCY CLASSES AND POLLEN FERTILITY OF *Crinum spp.*



5. Crinum woodi ( $2n=22$ ). (Table 8, Fig.II, 5, Photoplate - IV, 19-20).

Pollen are orange, elliptic, dizonocolpate microreticulate with echinulate sculpturing, Pollen grains of the species were found to be largest among the species under study; unhydrated pollen ranged in size from  $81-118 \times 77-109 \mu$  averaging to  $100 \times 93 \mu$ . Acetolysed pollen ranged in size from  $81-131 \times 68-122 \mu$  averaging to  $103 \times 89 \mu$ . Size frequency classes ranging  $81-95 \mu \times 96-110 \mu$  equally dominated (Text FigII). About 95% pollens were found to be fertile and they are shed in 2-celled condition.

6. Crinum species ( $2n=33$ ). (Table 8, Fig.II, 6, Photoplate-IV, 21-22).

Crinum sp. with  $2n=33$  and very long, pink flowers of about 20-30 cm long cultivated at various Government offices.

Crinum species with very large leaves inflorescence and long pink flowers (20-30 cm) is cultivated at various Government offices in Kolhapur. Most probably it is introduced by Britishers. The identification of the species could not be confirmed. It is a triploid with  $2n=33$ . The pollens are orange, elliptic, dizonocolpate, microreticulate with echinulate sculpturing. The size of unhydrated pollen ranged from  $63-99 \times 54-90 \mu$  averaging to  $85 \times 70 \mu$ . Acetolysed pollen ranged in size from  $63-99 \times 45-86 \mu$ ; averaging to  $83 \times 68 \mu$  size frequency

class of 81-95  $\mu$  dominated in the pollen (Text Fig.II). In spite of triploid nature, pollen fertility was found to about 60%. Pollens are shed in 2-celled condition.

7. Crinum species ( $2n=44$ ). (Table 8, Fig.II, 7; Photoplate - IV, 23-24).

This Crinum species closely resembles C. asiaticum, however, in addition to tetraploid status, has revealed distinctive characters of its own. It produces seeds and sexual reproduction is observed in natural habitats as well as in cultivated plants. It could be a new species of Crinum.

Pollen are orange, elliptic, dizoonocolpate, reticulate with echinulate sculpturing. Size of unhydrated pollen ranged from 54-100 X 49-79  $\mu$  averaging to 67 X 61  $\mu$ . Acetolyzed pollen ranged in size from 63-100 X 36-86  $\mu$  averaging to 80 X 71  $\mu$ . Pollen size frequency class A (50-65  $\mu$ ) X B (66-80  $\mu$ ), dominated equally in pollen grains (Text Fig.II) Pollen fertility was found to be as high as 92% and pollen grains are shed in 2-celled condition.

Thus, pollen morphology in different species varied insignificantly. Largest pollen were observed in C. woodrowii and white-gray colour of pollen is diagnostic to C. latifolium.

### Anatomy

There are no good taxonomic characters for identification of Crinum species. This is also the case with many other bulbous plants of monocots. Identifications are mainly based on quantitative characters. Quantitative characters of closely related species always overlap with each other making it difficult to identification of the species. Leaf characters are mainly used in identification of Crinum species. Therefore, detailed leaf morphology, anatomy of leaf has been investigated. Similarly to understand interrelationship and evolution of Crinum species, vessel characters have been studied. However, these characters are found to be of limited value as morphological characters.

Leaf morphology - (Table 9, Photoplate V 25-30, Photoplate VI 31-38)

The leaves in Crinum species show considerable variation in size, shape and thickness. It is found to be of taxonomic value. Mainly the breadth of leaf is used for identification of species. Our observation on leaf morphology indicated that Length/Breadth ratio is more reliable character in identification of species. In addition to these, other anatomical characters of leaf, cuticle and vessels have been studied.

Leaves are long, linear-lanceolate to ensiform to strap-shaped. They are thick and show xerophytic characters.

Transsection of leaf shows that leaves are isobilateral and amphistomatic. The upper and lower epidermis is made up of rectangular, polygonal cells. The epidermis is covered by cuticle and wax. The continuity of epidermis is broken by stomata. The mesophyll is not distinguished into palisade and spongy tissue. The mesophyll consists of circular parenchymatous cells packed with chloroplasts, and chlorenchym-a enclose large number of air-spaces. The general anatomical features of Transection of leaf remained same in all the species of Crinum. Only thickness of leaf varied in different species which in turn varies from base to apex and from midrib to margin of leaf (Table ). The average thickness of leaf in basal region varied from 1.1 to 2.3; from 0.84 to 1.2 in middle region, and from 0.42 to 1.03 in upper part of leaf. Thicker leaves were observed in tetraploid population of Crinum (1.85 mm) followed by Crinum asiaticum (1.73 mm) and minimum thickness of leaf was observed in Crinum pratense (1.06 mm). The length of epidermal cell varied from 126 (C. brachynema) to 418 (C. woodrowii). Similarly breadth of epidermal cell varied from 34.5 (C. pratense) to 49.5 (Crinum sp. Tetraploid). Largest epidermal cells were observed in Tetraploid of Crinum, followed by C. woodrowii and smallest were found in C. pratense.

The stomatal index varied from 13.1 (C. asiaticum) to 23.8 (C. woodrowii) on upper epidermis and from 16.2 (Tetraploid) to 25.2 (C. woodrowii) on lower

Table No. 9 : Showing comparative account of culticular characteristics of leaf of Crinum species

Sr. No.	Characters	Name of Species							
		<u>C. asiaticum</u> 2n=22	<u>C. brachynema</u> 2n=22	<u>C. defixum</u> 2n=22	<u>C. latifolium</u> 2n=22	<u>C. pratense</u> 2n=22	<u>C. woodrowii</u> 2n=22	<u>C. spp.</u> 2n=33	<u>C. spp.</u> 2n=44
1.	Leaf length (L) (cm)	90-150	45-60	60-90	50-100	40- 70	30- 40	---	45- 75
2.	Leaf breadth (B) (cm)	10- 18	7-10	2-3.5	7- 15	3- 5	7- 10	---	8-13.5
3.	L X B	2700	600	315	1500	350	400	---	1012
4.	Thickness of leaf at base (mm)	2.63	1.53	1.54	1.56	1.16	1.11	1.84	2.28
	at middle (mm)	1.69	1.49	0.95	1.52	0.94	0.84	1.80	1.21
	at apex (mm)	0.44	0.44	0.42	0.43	0.54	0.60	0.68	1.03
	Average thickness of leaf (mm)	1.73	1.3	1.11	1.31	1.06	1.05	1.66	1.85
5.	Epidermal cell length (u)	152.10 + 13.63	126.31 + 25.38	408.43 + 112.56	219.07 + 39.72	317.44 + 93.82	418.93 + 63.12	316.73 + 52.16	149.21 + 17.30
6.	Epidermal cell breadth (u)	54.90 + 8.83	36.60 + 9.75	40.94 + 5.75	34.97 + 3.76	34.49 + 4.06	39.90 + 5.10	34.79 + 4.07	49.50 + 3.44
7.	Stomatal Index (S.I.) on upper epidermis	13.13	14.49	16.19	20.83	14.44	23.80	14.47	13.27
	on lower epidermis	16.66	24.16	17.42	24.20	17.73	25.21	18.18	16.20
	Average S.I.	14.89	19.32	16.80	22.51	16.03	24.50	16.32	14.73
8.	Stomatal length L (u)	59.93 + 4.89	57.62 + 5.47	59.73 + 5.13	48.90 + 3.70	48.19 + 4.18	48.10 + 4.15	46.02 + 5.49	64.68 + 10.34
9.	Stomatal breadth B (u)	53.81 + 5.1	40.73 + 5.23	42.76 + 3.94	27.90 + 4.65	37.68 + 5.01	35.60 + 5.0	25.00 + 3.92	39.50 + 5.31

epidermis. Average maximum stomatal index was found in C. woodrowii (24.50), C. latifolium (22.5) and minimum in tetraploid Crinum spp. (14.7). Stomatal length varied from 48.1 (C. woodrowii) to 64.7 (Tetraploid Crinum spp.) and stomatal breadth varied from 25.00 (Triploid Crinum spp.) to 53.8 (Crinum asiaticum).

Cytology :

Karyomorphology of three diploid and one tetraploid species of Crinum have been studied in present investigation while Crinum pratense, C. latifolium and C. brachynema were found to be diploids showing  $2n = 22$  (photoplate VII Fig. 39-41 45), Crinum species with large glaucous green leaves was found to be tetraploid  $2n = 44$  (photoplate VII Fig. 45). The diploid and haploid chromosome number for C. brachynema and C. pratense is reported for first time. Wild tetraploid Crinum species, closely related to C. asiaticum shows fairly normal meiosis and may prove to be a new species of Crinum.

Chromosomes were found to be of four major types and are categorised as follows.

- Type A : Long chromosome ( 9.95 - 13.5  $\mu$  ) with constriction in the median (m) region.
- Type B : Medium SAT chromosome ( 7.12 - 9.36  $\mu$  ) with constriction in the submedian (sm) region.
- Type C<sub>1</sub> : Medium chromosome ( 6.44 - 10.24  $\mu$  ) with constriction in the median (m) region.
- Type C<sub>2</sub> : Medium chromosome ( 6.44 - 10.24  $\mu$  ) with constriction in the submedian (sm) region.
- Type C<sub>3</sub> : Medium chromosome ( 6.44 - 10.20  $\mu$  ) with constriction in the subterminal (st) region.

- Type D<sub>1</sub> : Short chromosome (3.93 - 6.08  $\mu$ ) with constriction in the Median (M) region.
- Type D<sub>2</sub> : Short chromosome ( 3.93 - 6.08  $\mu$  ) with constriction in the median (m) region.
- Type D<sub>3</sub> : Short chromosome ( 3.93 - 6.08  $\mu$  ) with constriction in the submedian (sm) region.

Somatic chromosomes of Crinum brachynema (Plate VII Fig.39), C. latifolium (Plate VII Fig.40), C. pratense (Plate VII Fig.41) and Crinum spp. (Tetraploid) (Plate VII Fig.45) with karyomorphological details are presented in ~~Tables~~ 10 to 13. Comparative account of chromosome numbers and karyotypic parameters of Crinum species under study is shown in ~~Table~~ 14 and presented Idiographically in Fig.III.

Accessory chromosomes from 1-4 (Photoplate VII Fig.42-44) are found in population of Crinum pratense growing on barren plateaus of western ghats situated at higher altituded. This forms a first report of presense of B-chromosomes for the species.

A gross similarity was observed in chromosome morphology of Crinum species. The general karyotypic formula viz 2L + 2SATM + 10M + 8S is applicable to all the three diploid species of Crinum and it is equally applicable to tetraploid species of Crinum, except detection of sat chromosomes. Exact double numbers of Long ~~8~~ Medium and Short chromosomes were observed in tetraploid.



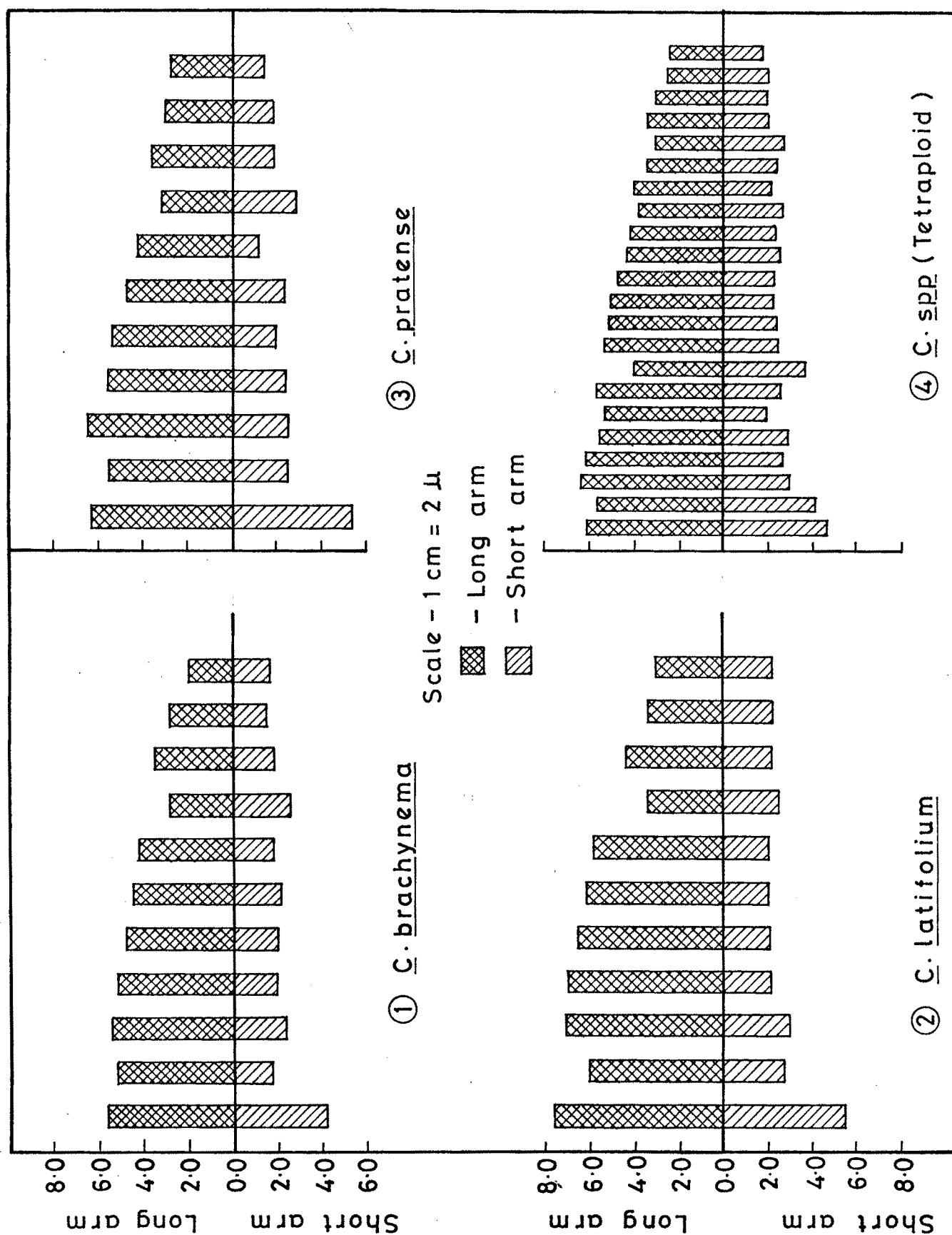


FIG. III (1-4) - IDIOGRAM OF CRINUM SPECIES (KARYOTYPE).

Table No. 10 : Showing karyomorphological Details of Crinum brachynema

Chro. No.	C L + S	L	S	R = L/S	R = L-S	$I = \frac{100S}{C}$	F%	TF%	TCL%	S%	Stebbins Classifi- cation
I	9.96 <u>+1.19</u>	5.59 <u>+0.74</u>	4.36 <u>+0.78</u>	1.28	1.23	6.12	43.77	---	14.00	---	m
* II	7.12 <u>+0.99</u>	5.22 <u>+1.01</u>	1.89 <u>+0.19</u>	2.76	3.33	2.65	26.54	---	10.00	---	sm
III	7.78 <u>+0.95</u>	5.39 <u>+0.74</u>	2.42 <u>+0.49</u>	2.22	2.97	3.40	31.10	---	10.93	---	sm
IV	7.23 <u>+0.76</u>	5.14 <u>+0.66</u>	2.04 <u>+0.36</u>	2.51	3.10	2.86	28.21	---	10.16	---	sm
V	6.89 <u>+1.00</u>	4.87 <u>+1.55</u>	2.02 <u>+0.31</u>	2.41	2.85	2.83	29.31	35.25	9.68	39.45	sm
VI	6.57 <u>+0.72</u>	4.44 <u>+0.70</u>	2.13 <u>+0.50</u>	2.08	2.31	2.99	32.42	---	9.23	---	sm
VII	6.15 <u>+0.64</u>	4.11 <u>+0.61</u>	1.99 <u>+0.49</u>	2.06	2.12	2.79	32.35	---	8.64	---	sm
VIII	5.50 <u>+0.64</u>	2.88 <u>+0.46</u>	2.62 <u>+0.31</u>	1.05	0.26	3.68	47.63	---	7.73	---	m
IX	5.48 <u>+0.58</u>	3.49 <u>+0.53</u>	1.98 <u>+0.38</u>	1.76	1.51	2.78	36.13	---	7.70	---	m
X	4.52 <u>+0.57</u>	2.70 <u>+0.30</u>	1.75 <u>+0.39</u>	1.54	0.95	2.46	38.71	---	6.35	---	m
XI	3.93 <u>+0.62</u>	1.95 <u>+0.44</u>	1.08 <u>+0.43</u>	1.03	0.07	2.64	47.83	---	5.52	---	m
Total	71.13 <u>+8.66</u>	45.78 <u>+6.74</u>	25.08 <u>+4.63</u>								

Table No. 11 : Showing karyomorphological details of Crinum latifolium

Chro. No.	C	L	S	R = L/S	R = L-S	$I = \frac{100S}{C}$	F%	TF%	TCL%	S%	Stebbins Classifica- tion
I	13.30 + 1.85 + 1.85	7.65 + 1.29 + 1.29	5.69 + 1.50 + 1.50	1.34	1.96	6.27	42.78	---	14.67	---	m
* II	8.98 + 1.33 + 1.33	6.08 + 1.01 + 1.01	2.89 + 0.49 + 0.49	2.10	3.19	3.18	32.18	---	9.90	---	sm
III	10.24 + 1.42 + 1.42	7.19 + 1.28 + 1.28	3.07 + 1.12 + 1.12	2.34	4.12	3.38	29.98	---	11.29	---	sm
IV	9.36 + 0.95 + 0.95	7.09 + 0.97 + 0.97	2.26 + 0.76 + 0.76	3.13	4.83	2.49	24.14	---	10.32	---	st
V	8.92 + 0.81 + 0.81	6.69 + 0.81 + 0.81	2.19 + 0.43 + 0.43	3.05	4.50	2.41	24.55	32.85	9.84	39.77	sm
VI	8.31 + 1.42 + 1.42	6.27 + 0.86 + 0.86	2.10 + 0.54 + 0.54	2.98	4.17	2.31	25.27	---	9.16	---	sm
VII	8.00 + 1.01 + 1.01	5.81 + 0.98 + 0.98	2.19 + 1.14 + 1.14	2.65	3.62	2.41	27.37	---	8.82	---	sm
VIII	6.08 + 1.13 + 1.13	3.41 + 0.43 + 0.43	2.57 + 0.56 + 0.56	1.32	0.84	2.83	42.26	---	6.70	---	m
IX	6.51 + 1.10 + 1.10	4.32 + 0.93 + 0.93	2.20 + 0.52 + 0.52	1.96	2.12	2.42	33.79	---	7.18	---	sm
X	5.66 + 0.72 + 0.72	3.34 + 0.65 + 0.65	2.32 + 0.33 + 0.33	1.43	1.02	2.55	40.98	---	6.24	---	m
XI	5.29 + 1.08 + 1.08	3.07 + 0.68 + 0.68	2.22 + 0.52 + 0.52	1.38	0.85	2.44	41.96	---	5.83	---	m
Total	90.65 +13.02 +13.02	60.92 + 9.97 + 9.97	29.73 + 7.99 + 7.99								

Table no. 12 : Showing karyomorphological details of Crinum pratense

Chro. No.	C	L	S	R=L/S	R=L-S	$I = \frac{100S}{C}$	F%	TF%	TCL%	S%	Stebbins Classifica- tion
I	11.77 + 2.94 ±	6.35 + 2.33 ±	5.42 + 1.44 ±	1.17	0.93	6.86	46.04	---	14.91	---	m
II	8.04 + 1.66 ±	5.57 + 1.33 ±	2.47 + 0.66 ±	2.25	3.1	3.13	30.72	---	10.19	---	sm
III	9.04 + 2.14 ±	6.55 + 2.07 ±	2.49 + 0.51 ±	2.63	4.06	3.15	27.54	---	11.45	---	sm
IV	8.05 + 1.61 ±	5.63 + 1.30 ±	2.42 + 0.69 ±	2.32	3.21	3.06	30.06	---	10.20	---	sm
V	7.50 + 1.52 ±	5.39 + 1.20 ±	1.99 + 0.72 ±	2.70	3.4	2.52	26.53	33.75	9.50	37.63	sm
VI	7.20 + 1.66 ±	4.77 + 1.38 ±	2.43 + 0.56 ±	1.96	2.34	3.07	33.75	---	9.12	---	sm
VII	6.44 + 1.57 ±	4.26 + 1.39 ±	1.18 + 0.79 ±	3.61	3.08	1.49	18.32	---	8.16	---	st
VIII	5.99 + 1.39 ±	3.11 + 0.65 ±	2.85 + 0.88 ±	1.09	0.26	3.61	47.57	---	7.59	---	m
IX	5.53 + 1.42 ±	3.65 + 1.05 ±	1.88 + 0.49 ±	1.94	1.77	2.38	33.99	---	7.00	---	sm
X	4.91 + 1.23 ±	3.04 + 0.82 ±	1.87 + 0.61 ±	1.62	1.17	2.37	38.08	---	6.22	---	m
XI	4.43 + 0.97 ±	2.87 + 0.71 ±	1.55 + 0.41 ±	1.85	1.32	1.96	34.98	---	5.61	---	sm
Total Length	78.9 +18.11 ±	52.27 +11.93 ±	26.63 + 7.76 ±								

Table No. 13 : Showing karyomorphological details of Crinum spp. (Tetraploid)

Chro. No.	C	L	S	R = L/S	R · L-S	$I = \frac{100S}{C}$	F%	TF%	TCL%	S%	Stebbins Classifica- tion
I	10.90 ± 0.61	6.15 ± 0.98	4.74 ± 0.83	1.29	1.41	2.97	43.48	---	6.85	---	m
II	9.95 ± 1.18	5.71 ± 1.09	4.22 ± 0.67	1.35	1.49	2.65	42.41	---	6.25	---	m
III	9.45 ± 1.38	6.41 ± 0.87	3.04 ± 1.12	2.10	3.37	1.91	32.16	---	5.93	---	sm
IV	8.93 ± 0.93	6.19 ± 0.81	2.74 ± 0.49	2.25	3.45	1.72	30.68	---	5.93	---	sm
V	8.35 ± 1.16	5.63 ± 0.91	2.85 ± 0.48	1.97	2.78	1.79	34.13	---	5.24	---	sm
VI	7.59 ± 0.68	5.45 ± 1.32	2.05 ± 0.41	2.65	3.4	1.28	27.00	---	4.77	---	sm
VII	8.34 ± 1.04	5.78 ± 0.92	2.59 ± 0.49	2.23	3.19	1.61	31.05	---	5.24	---	sm
VIII	7.75 ± 0.92	4.07 ± 0.56	3.70 ± 0.51	1.11	0.37	2.32	47.74	36.97	4.87	38.16	m
IX	7.93 ± 0.98	5.41 ± 1.15	2.55 ± 0.33	2.12	2.86	1.60	32.15	---	4.98	---	Sm
X	7.69 ± 0.98	5.28 ± 0.85	2.37 ± 0.54	2.22	2.91	1.48	30.81	---	4.83	---	Sm
XI	7.45 ± 1.04	5.15 ± 0.83	2.29 ± 0.41	2.24	2.86	1.43	30.73	---	4.68	---	Sm
XII	7.08 ± 0.83	4.74 ± 0.78	2.33 ± 0.33	2.03	2.41	1.46	32.90	---	4.44	---	Sm
XIII	6.94 ± 0.79	4.34 ± 0.47	2.61 ± 0.81	1.66	1.73	1.64	37.60	---	4.36	---	m
XIV	6.68 ± 0.84	4.20 ± 0.86	2.49 ± 0.67	1.68	1.71	1.56	37.27	---	4.19	---	m
XV	6.49 ± 0.84	3.82 ± 0.58	2.67 ± 0.54	1.43	1.15	1.67	41.14	---	4.07	---	m
XVI	6.27 ± 1.21	4.04 ± 0.76	2.22 ± 0.47	1.81	1.82	1.39	35.40	---	3.94	---	Sm
XVII	5.83 ± 0.80	3.40 ± 0.50	2.40 ± 0.39	1.41	1.0	1.50	41.16	---	3.66	---	m
XVIII	5.93 ± 0.81	2.99 ± 0.68	2.77 ± 0.42	0.92	0.22	1.74	46.71	---	3.72	---	m
XIX	5.49 ± 0.89	3.40 ± 0.76	4.09 ± 0.37	1.62	1.31	1.31	38.06	---	3.45	---	m
XX	5.07 ± 0.69	3.06 ± 0.60	2.02 ± 0.37	1.51	1.04	1.26	39.48	---	3.18	---	m
XXI	4.63 ± 0.90	2.52 ± 0.65	2.12 ± 0.36	1.18	0.40	1.33	45.78	---	2.90	---	m
XXII	4.16 ± 0.68	2.41 ± 0.44	1.75 ± 0.34	1.37	0.66	1.09	42.06	---	2.61	---	m
Total Length	159.11 ±20.55	101.96 ±17.37	58.83 ±11.35								

Table No. 14 : Showing details of chromosome numbers, karyotypic parameters and pollen fertility of various Crinum species from Maharashtra

Sr. No.	Name of Species	Locality	2n . n .	Karyotype formula	Total ACL haploid chromat in length (mu)	Pollen fertility %	F% to	TF% to	TCL% to	S% to	Karyotype symmetry stebbins notation (1958)
I	<u>C. brachynema</u>	Mahabaleshwar	22 11	$2A^m+2B^{sm}+10C_2^{sm}+4D_1^M+4D_2^M$	71.13	6.46 u	26.54 to 47.83	35.25	5.52 to 14.00	39.45	2B
II	<u>C. latifolium</u>	Kolhapur, University Botanical Garden	22 11	$2A^m+2B^{sm}+8C_2^{sm}+2C_3^{st}+6D_2^m+2D_3^{sm}$	90.65	8.24 u	24.14 to 47.78	32.85	5.83 to 14.67	39.77	2B
III	<u>C. pratense</u>	Barkiplateau, Kas Plateau	22 11	$2A^m+2B^{sm}+8C_2^{sm}+2C_3^{st}+4D_2^m+4D_3^{sm}$	78.9	7.17 u	18.32 to 47.57	33.75	5.61 to 14.91	37.63	2B
IV	<u>C. spp.</u>	Kas, Radhanagari	44 22	$4A^m+0B^{sm}+8C^m+18C_2^{sm}+2D_1^M+10D_2^m+2D_3^{sm}$	159.11	7.26 u	27.00 to 47.74	36.97	2.61 to 6.85	38.16	2B

Total haploid chromosome length was found to be minimum in C. brachynema (71.13  $\mu$ ) followed by C. pratense (78.9  $\mu$ ) and C. latifolium (90.65  $\mu$ ). Total chromosome length (159.11 $\mu$ ) in tetraploid species of Crinum was found to be approximately double to the diploid species. Average chromosome length was found to be minimum in C. brachynema (6.46  $\mu$ ) followed by C. pratense (7.17  $\mu$ ), Tetraploid (7.26  $\mu$ ) and C. latifolium (8.24  $\mu$ ).

A pair of long median (m) chromosome was common to all the three diploid species. There were two pairs of long median (m) chromosomes in tetraploid. A pair of SAT submedian (sm) chromosomes was common to all three diploid species, however SAT chromosomes could not be detected in tetraploid. There were five pairs in diploids and 12 pairs in tetraploid of medium usually submedian (sm) and rarely median (m) or subterminal (st) type of chromosomes. Similarly 4 pairs of short chromosomes with constriction in median (m) or submedian (sm) region were found in diploid and 8 pairs in tetraploid. Thus the gross chromosome morphology was similar in diploid as well as Tetraploid species.

Meiotic studies on Crinum defixum (Plate VIII Fig.46-51) revealed the normal stages of meiosis. Meiocytes of Crinum showed 11 bivalents (Plate VIII 46,47) , with normal diakinesis (Plate VIII Fig.46,47), normal metaphase I (Plate VIII Fig.48), however, there

were certain events (Plate VIII Fig.49-51) such as bridge configuration and presence of laggards, indicating translocations.

Crinum latifolium showed normal meiosis (Plate IX Fig.52-60). Normal diakinesis showed grouping of some bivalents (Plate IX Fig.53) while metaphase I was found normal (Plate IX Fig.55) or with laggard (Plate IX Fig.54). Normal anaphase I (Plate IX, Fig.56) showed prominent spindle apparatus ~~showed prominent spindle~~ apparatus. Some meiocytes (Plate IX Fig.57,58) showed less DNA content in general leading to pollen sterility in some plants. Normal anaphase I (Plate IX Fig.59) and normal telophase (Plate IX Fig.60) was observed.

Although all the stages of meiosis could not be obtained in tetraploid species of Crinum, however, it showed normal metaphase (Plate X Fig.61), metaphase with laggard (Plate X Fig.62), early anaphase I with sticky chromosome (Plate X Fig.63), anaphase with laggards and chromosome bridges (Plate X Fig.64,65). Laggards and bridges in tetraploid indicate translocations in their chromosome complement. Other stages such as Interphase II (Plate X Fig.66), metaphase II (Plate X Fig.67), Telophase II (Plate X Fig.68) and tetrad stage (Plate X Fig.69) were normal. Cytokinesis was of simultaneous type resulting into isobilateral tetrads.



### Hybridization

Hybridization among different species of Crinum was tried. Most of the crosses tried were successful indicating loose interspecific incompatibility among the species of Crinum. Most of the species come in flowering during April-May under cultivation. Flowering can be manipulated by watering practice. Anther dehiscence takes place in bud condition about 3-4 hours before opening of the flower-bud. Anthesis starts around 2 pm and flower opens between 6-7 pm in all the Crinum under study. Flower buds to be going to open on the day were emasculated in morning and anthers were stored in petriplates. Pollen from same anther were used on same day for interspecific hybridization. After opening of flower bud, pollens were dusted on stigma and then whole inflorescence was bagged by large polythene bags. Following crosses were tried :

1. Crinum latifolium X C. spp (Tetraploid) : Successful
2. C. spp (Tetraploid) X C. latifolium : Successful
3. C. asiaticum X C. spp (Tetraploid) : Successful
4. C. pratense X C. defixum : Successful
5. C. defixum X C. pratense : Successful

Of all the crosses tried, only two crosses were unsuccessful, Crinum spp. (Tetraploid) does not cross with C. pratense and C. defixum. The hybrid seeds were collected and germinated separately in earthen pots. Hybrids are under cultivation and observation.