CHAPTER III

OBSERVATIONS

M O R P H O L O G I C A L   O B S E R V A T I O N S

MORPHOLOGICAL OBSERVATIONS

Morphological description, based on the study of different populations for each species, is given. This is done with a view to compare them and know variations.

The abbreviations used in the enumeration are as follows :

Amer. Nat.	The American Naturalist.
Bhandari	Flora of the Indian Desert.
C.	The Flora of the Presidency of Bombay (Reprimted edition) : by Cooke, Th.
DC. Prodr.	Prodromus Systematis Naturalis Regni Vegetabilis : 13(1) by Dunal.
FBI.	The Flora of British India : by Hooker, J. D.
FGS.	Flora of Gujarat State : (Part I) by Shah, G. L.
Fl. Mad.	Flora of the Presidency of Madras : by Gamble, J.S. and C.E.C. Fischer.
Fl. Del.	The Flora of Delhi State : by Maheshwari, J.K.
Gard. Dict.	The Gardener's Dictionary : by Miller.

JBNHS.	....	Journal of Bombay Natural History Society.
Sp. Pl.	....	Species Plantarum : by Linneaus.
Syn. Pl.	....	Synopsis Plantarum : by Persoon.
Saur.	....	The Flora of Saurashtra (Vol. I) : by Santapau, H.

SOLANACEAE

Nicandra Adans. (nom. cons.)

Nicandra physalodes (= physaloides) (L.) Gaertn. FBI. 4: 240; C. 2: 346; Bailey, 871; FGS. 1: 486.

Atropa physalodes L. Sp. Pl. 181, 1753.

An erect, annual herb, upto 70 cm. tall. Stem and branches glabrous. Leaves - simple, 6.5 to 10.5 cm. in length and 2.5 to 4.5 cm. in breadth, ovate-oblong or lanceolate, entire or irregularly toothed or sinuate, obtuse, cuneate or oblique, slightly hairy; petiole - 2 to 3.5 cm. long. Flowers - axillary, solitary, purple blue; pedicel - 1.3 to 2.1 cm. long; calyx - 5 partite, 7 to 9 mm. long, cordate, acute, auricled; corolla - 5-plaited, gamopetalous, 2.5 cm. across, campanulate; stamens - 5, epipetalous, filaments - hairy at base, anthers oblong, golden yellow; ovary - ovoid, placed high on a yellow disc, style - 4 mm. long, glistening white, stigma - obscurely 3-5 lobed. Fruit - berry, large, globose, green, yellow brown when mature, completely enclosed by accrescent calyx, more than 100 seeds per berry. Seeds - small, subdiscoid, compressed, deep brown.

Fls. & Frs. - August to November.

SKT. 16, 8, 21.

Observed in open areas along with the grasses as an undergrowth. It is also cultivated as ornamental plant.

Source : Seeds of Coll. Nos. 8 and 21 obtained from Botanical Gardens of Kew and Copenhagen, respectively.

Lycium L.

Lycium barbarum L. Sp. Pl. 192, 1753; FBI. 4: 241; C. 2: 342; Bhandari, 270; FGS. 1: 485.

An erect, spinous, tall shrub. Stem and branches - glabrous, branches white or grey with sharp conical spines which often elongate and bear leaves and flowers. Leaves - simple, small, alternate or fascicled, oblong-lanceolate or linear, entire, obtuse; petiole-short. Flowers - solitary or in fascicles of 2 to 5 flowers, nearly white; pedicel - filiform, 5-6 mm. long; calyx - 5-lobed, 3 to 4 mm. long, campanulate, often becoming irregularly lobed, sepal oblong, obtuse, glabrous, somewhat rugose outside; corolla - 5-lobed, rarely 4, tubular, 10 to 12 mm., petal oblong, obtuse, glabrous; stamens - 5 rarely 4, exserted, filament - flat, densely hairy at base, anthers - oblong; ovary - ovoid-oblong, seated on a cup shaped disc, style - long, glabrous; stigma - subcapitate. Fruit - berry, small, globose or oblong, bright red accrescent calyx often deformed, seed few. Seeds - 2-5 mm. in diameter, discoid, compressed, orange yellow to brown (Pl. I:1).

Fls. & Frs. - September to March.

SKT. 15.

Pl. 1:1 - Habit of *Lycium barbarum*.

PL. I:I

Observed in dry areas of Kutch near the railway line and in open waste land.

Withania Pauq. (nom. cons.)

Withania somnifera (L.) Dunal DC. Prodr. 13, 1: 458, 1852; FBI. 4: 239; C. 2: 341; FGS.1:492.

Physalis somnifera L. Sp. Pl. 182, 1753.

An erect undershrub 100 to 152 cm. tall. Stem and branches - terete, thickly covered with stellate hoary tomentum. Leaves - simple, 7 to 10 cm. in length and 3 to 5 cm. in breadth, ovate, entire, subacute, base acute, thick, stellately pubescent; petiole short, stellately tomentose. Flowers - in umbellate cymes, green or lurid yellow; pedicel - very short; calyx - 5-toothed, sometimes 6, teeth linear, acute; corolla - 5-lobed, gamopetalous, 7 to 10 mm., lobes lanceolate, acute, pubescent outside; stamens - 5, attached near the base of corolla, filament - small, linear, glabrous, anthers - broadly elliptic; ovary - globose, glabrous, style - small, glabrous, stigma - shortly bifid. Fruit - berry, small, 4 to 6 mm. across, globose, red when mature, enclosed in accrescent calyx, which is slightly 5 angled in fruiting stage, 15-20 seeds per berry; seeds - small, discoid, compressed, light brown.

Fls. & Frs. - Throughout the year.

SKT. 14, 60.

Observed as waste land weed or along the roadsides. Very common.

Physalis L.

Physalis longifolia Nutt. in Trans. Amer. Phil. Soc. 5: 93, 1837; Dunal DC. Prodr. 13, 1: 447, 1852; Santapau et al., JBNHS. 58, 2: 550-51, 1961; FGS. 1: 488.

An erect, annual herb 90 to 120 cm. tall. Stem - 3-4 ridged or furrowed, hollow, pubescent in younger parts but glabrous in older, stem and branches dichotomously branched. Leaves - simple, upto 11 cm. in length and 5 cm. in breadth, ovate or ovate-oblong, mostly entire, occasionally irregularly toothed or sinuate, apex acute to acuminate, base cuneate or oblique, sparsely hairy; petiole - long, grooved, rosettes may be present at base. Flowers - solitary axillary, yellow, erect or partially nodding; pedicel - 0.8 to 1.7 cm. long, filiform, glabrous; calyx - 5-lobed, gamosepalous campanulate, lobes somewhat triangular, pubescent outside; corolla - 5-lobed, gamopetalous, campanulate, more than 1 cm. across, with purple or brown spots in centre; hairy near the base on the inner side; stamens - 5, attached near the base of corolla, filament - 2.5 to 3.25 mm., pale yellow with purple tinge, smooth; anthers - greyish blue; ovary - globose; style - 3.25 mm. long, glabrous; stigma - obscurely bilobed. Fruit - berry, large more than 8 mm. across, globose, green, enclosed by accrescent ribbed calyx, ribs and veins deeply purple, 78-140 seeds per berry.

Seeds - small, auriculate, compressed, yellow brown-buff yellow.

Fls. & Frs. - July to November.

SKT. 38, 39, 41, 43, 45.

Observed among the grasses near cultivated fields. Almost available throughout the year.

Different populations of the taxa show following morphological differences.

Coll. Nos. 38, 41.	Plants erect. Stem prominently ridged, dichotomously branched, rosettes absent. Leaves larger in size with 2-3 tooth on each side. Stamens 3+2. 3 have long filament and 2 have short. Accrescent calyx ribs and veins lightly purple.
Coll. Nos. 39, 43.	Plant decumbent to prostrate. Stem, branches and petiole clothed with fine, silvery hairs. Leaves small in size. Margin entire or lightly sinuate. All stamens of almost equal length. Accrescent calyx rib and veins deeply purple.
Coll. No. 45.	Plant very small in height. Leaves medium sized.

Physalis minima L. Sp. Pl. 183, 1753; FBI. 4: 238; C. 2: 340; FGS. 1: 488.

A diffused straggling, annual herb. Stem and branches - ridged, scantily covered by coarse white hairs. Leaves - simple, 3.5 - 7 cm. in length and 2-4 cm. in breadth, ovate, sinuate or distinctly toothed, apex acute, base cuneate or truncate, sparsely hairy on both sides; petiole - 1.5 to 3.5 cm., hairy, rosette of 1-3 leaves present near the base. Flowers - solitary, axillary, light yellow, generally nodding; pedicel - 3 to 6 mm. long, filiform, glabrous; calyx - 5-lobed, gamosepalous, teeth triangular, equalling the tube, scantily hairy outside; corolla - 5-lobed, 5-7 mm. across, campanulate; stamens - 5, filament - 2 to 2.5 mm. long, glabrous or ½ pubescent; anthers - bluish grey, oblong; ovary - ovoid or subglobose, seated on a large disc; style - 3.5 mm. exceeds anthers, glabrous; stigma - obscurely bilobed. Fruit - berry, large, subglobose, green, enclosed by accrescent 10-ribbed calyx; seeds - slightly larger than that of P. longifolia, 44 to 64 seeds per berry, discoid, yellow brown.

Fls. & Frs. - July to October.

SKT. 37, 40, 42.

Observed in places near the cultivated land and in shady places.

The populations of Physalis minima L. differ from each other in following morphological features.

Coll. No. 37 — Plants prostrate to suberect, stem and branches prominently ridged. Leaves ovate-lanceolate, distinctly toothed which are alternately large and small.

Coll. Nos. 40, 42. — Plants decumbent, stem & branches hairy. Leaves lanceolate, margin entire to lightly sinuate. Flowers greenish yellow.

Solanum L.

Solanum villosum Mill. subsp. villosum Edmonds, Bot. Jour. Linn. Soc. 78: 214, 1979.

S. nigrum L. var. villosum L., Sp. Pl. 186, 1753.

S. luteum Mill. Gard. Dict. 1768.

A small, decumbent to erect annual herb upto 50 cm. in height. Stem - terete, tinted purple subglabrous. Branches - subglabrous to villous. Leaves - simple 3 to 5.5 cm. long and 1.5 to 3.5 cm. broad, ovate-lanceolate, entire to sinuate-dentate, apex acute, base cuneate or oblique covered by white coarse hairs on both the sides; petiole - 1.5 to 2.0 cm., hairy. Flowers - in extra axillary 4-5 flowered cymes, white; peduncle - 1.2 to 1.8 cm., hairy; pedicel - 6 to 8 mm.; calyx - 5-lobed, rarely 4, lobes 1 to 2.5 mm. in length, slightly triangular, hairy outside;

corolla - 5-lobed, approximately 1 cm. across, ovate, acute, petals deflexed, centre yellowish green; stamens - 5; filaments - short; anthers - 1 to 1.5 mm. long, oblong, golden yellow; ovary - ovoid; stigma - obscurely bilobed. Fruit - berry, 5 to 7 mm. in diameter, ovoid or subglobose, yellow or light pale red with slightly accrescent deflexed or adhering calyx, 15 to 24 seeds per berry with 2-3 stone grains. Seeds - small, light yellow, discoid.

Fls. & Frs. - August to December.

SKT. 31.

Seeds obtained from Botanical Garden, Copenhagen, Denmark.

Solanum villosum Mill. subsp. puniceum (Kirschleger) Edmonds, Bot. Jour. Linn. Soc. 78: 215, 1979.

S. nigrum L. subsp. puniceum Kirschleger, Flore d'Alsace et des contrées limitrophes, 1: 532, 1852, pro S. puniceum C.C. Gmelin quod est nom. illegit.

S. nigrum L. subsp. alatum (Moench) Celak. Prodromus der Flora von Böhmen: 309, 1871.

S. luteum Mill. subsp. alatum (Moench) Dostál, Květana ČSR, 1270, 1949.

A small, annual herb. Stem - 3-4 ridged, tinted purple at the base and nodes, densely pilose. Branches - ridged and pilose. Leaves - simple, 3.5 to 5 cm. in length and 2.5 to

3.5 cm. in breadth, ovate-lanceolate, 3 to 4 toothed on either side, apex acute to subacute, base cuneate, densely pubescent on upper surface; petiole - 1.6 to 2.5 cm., hairy. Flowers - in extra axillary 3-4 flowered cymes but usually 3, white; peduncle - 8 to 10.5 mm. long, covered with appressed hairs; pedicels - 6-8 mm. long, prominently thickened upwards, pubescent; calyx - 5-lobed (occasionally 4) 1.25 to 2 mm., ovate, entire, acute-obtuse, pubescent outside; corolla - 5 (rarely 4) - lobed, approximately 1 cm. across, petals ovate, acute with green central star; stamens - 5, filaments - usually 1 mm. or short, sparingly hairy, anthers - 1.75 to 2.25 mm., oblong, yellow; ovary - ovoid, style - exceeding anthers, pubescent upto ½ length, stigma - obscurely bifid. Fruit - berry, 7-8 mm. in diameter, subglobose, yellowish red, accrescent calyx often deformed 17-22 seeds and 5-7 stone grains per berry. Seeds - small, yellowish brown, discoid.

Fls. & Frs. - August to December.

SKT. 32.

Source : Seeds obtained from Botanical Garden, Copenhagen, Denmark.

<u>Solanum</u> <u>chenopodioides</u> Lam., Tableau encyclopédique et methodique des trois Règnes de la Nature. Botanique, 2: 18, 1794; Edmonds, Bot. Jour. Linn. Soc. 78: 226, 1979.

<u>S</u>. <u>gracile</u> Otto, The Gardners' Magazine, 9: 241, 1833 (<u>nom</u>. <u>nud</u>.).

S. gracile Dunal, DC. Prodr. 13, 1: 54, 1852.

S. ottonis Hylander, Uppsala Universitets Arsskrift, 7: 279, 1945.

A profusely branched straggling or reclining herb. Stem - prominently 3-4 ridged near the base, pubescent throughout. Leaves - simple, 5 to 7.5 cm. in length and 2.5 to 4 cm. in breadth, ovate or rhombic, mostly entire, apex acute, cuneate or oblique at the base, glabrescent; petiole - 2.0 to 3.5 cm. Flowers - in extra axillary, very rarely leaf opposed racemose cymes, 5-7 flowered, white; peduncle - 18.5 mm. to 21 mm., 30 mm. measured in 2 cymes, pubescent; pedicels - 6 to 8.5 mm., slender, appressed pubescent; calyx - 5-lobed (rarely 4); sepals ovate, lanceolate, acute to obtuse; corolla - 5-lobed, more than one cm. across; petals - ovate-deltoid, acute, yellow green central star; stamens - 5, filaments short, anthers - 2.5 to 2.9 mm., oblong, connivent, brown yellow; ovary - ovoid; style - hairy ½ the length; stigma - slightly bilobed. Fruit - berry, large, 7 to 9 mm. or more across, subglobose dull purple, calyx deformed, peduncle deflexed, 28 to 37 seeds and 1 or 2 stone grains per berry. Seeds - small, dirty yellow, discoid, compressed.

Fls. & Frs. - September to January.

SKT. 33.

Source : Seeds obtained from 'The Director, Botanical Gardens, Copenhagen, Denmark'.

<u>Solanum scabrum</u> Mill. Gard. Dict. 1768; Edmonds, Bot. Jour. Linn. Soc. 78: 224, 1979.

<u>S</u>. <u>guineense</u> (L.) Mill. Gard. Dict., 1768.

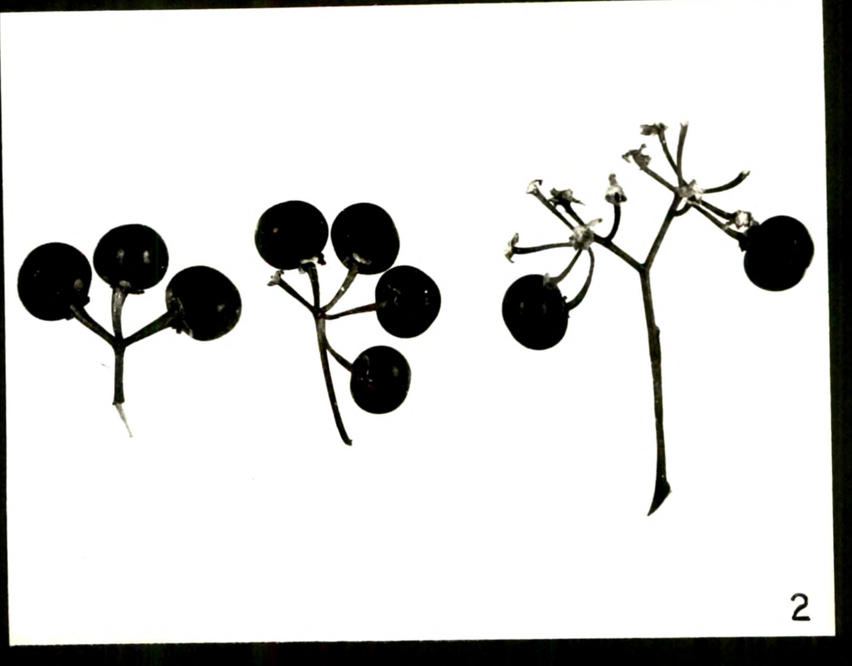
<u>S</u>. <u>nigrum</u> L. subsp. <u>guineense</u> (L.) Pers., Syn. Pl. 1:224, 1805.

An erect, annual herb more than 1 meter tall. Stem - with 3-4 corky ridges at base, rosettes present. Leaves - simple, upto 12 cm. in length and 8 cm. in breadth, ovate, entire, apex acute to subacute, base oblique, sparingly hairy on both the surface ; petiole - 4 to 5.5 cm., slightly grooved, curved. Flowers - in extra axillary umbellate cymes, 6 to 9 flowered, usually 7, white; peduncle - long, upto 21.5 mm.; pedicel - 5 to 7 mm., slender, lightly pubescent; calyx - 5-lobed, 1.5 to 1.75 mm. long, oblong, obtuse; corolla - 5-lobed, petals 5-6.5 mm. long, ovate, acute, central star yellow green; stamens - 5, epipetalous, filaments - 1.5 to 2 mm. in length, pubescent; anthers - 3 to 3.5 mm. long, oblong, brown, connivent into a coloumn; ovary - subglobose, style - exceeds the anthers, pubescent ½ length, stigma - bilobed. Fruit - berry, large, more than 1 cm. in diameter, globose, purple black, persistent calyx deformed, 60 or more seeds per berry. Seeds - small, buff yellow, discoid-auricled, compressed (Pl.I:2).

Fls. & Frs. - September to March.

SKT. 36.

Pl. 1:2 - Showing variations observed in number of fruits per inflorescence in *Solanum scabrum*.



PL. I:2

Solanum americanum Mill. Heiser Jr. *et al*. Amer. Nat. 99 (909): 472, 1965.

An erect, annual herb, more than 100 cm. tall. Stem - cylindrical, rosettes near the base when young. Leaves - simple, 8 to 13 cm. long and 3.5 to 6.5 cm. in breadth, ovate-deltoid ovate, entire to sinuate, occasionally one tooth on either side, apex acute to subacute, base cuneate sometimes oblique, sparsely pubescent; petiole - 3.5 to 6.5 cm. long, hairy. Flowers - in 3 to 5 flowered umbellate cymes, occasionally subracemose, usually 4, white; peduncle - 9 to 12 mm., pedicel - 3.5 to 5 mm. slightly nodding; calyx - 5-lobed, sepals 2 to 2.5 mm., ovate, entire, acute to obtuse; corolla - 5-lobed (rarely 6), petals 3 to 3.5 mm., lanceolate, acute, reflexed, central star green; stamens - 5, filaments - short, pubescent at base only, anthers - 1.3 to 1.7 mm., oblong, yellow, connivent into a cone; ovary - ovoid, style - equalling the anthers, ½ or less than half pubescent, stigma - obscurely bilobed. Fruit - berry, small, 4 to 7 mm. across, globose, shining purple black, accrescent calyx slightly deformed, more than 50 seeds and 4 to 7 stone grains per berry. Seeds - small, light yellow, discoid.

Fls. & Frs. - September to March.

SKT. 35.

Source : Seeds obtained from 'The Director, Botanical Gardens, Copenhagen, Denmark.'

<u>Solanum</u> <u>roxburghii</u> Dunal, DC. Prodr. 13, 1: 57, 1852; Heiser, Jr. <u>et</u> <u>al</u>. Amer. Nat. 99 (909): 472, 1965.

An erect or decumbent, annual herb, 70 to 80 cm. tall. Stem - 3-4 ridged, not branched from base, purple tinged. Leaves - simple, 5 to 9.5 cm. in length and 3.5 to 5.5 cm. in breadth, deltoid-ovate, sinuate or toothed, 3 to 4 teeth on each side, apex acute, base truncate; petiole - 2.5 to 4 cm., sparsely pubescent. Flowers - in subumbellate 3-8 flowered racemose cymes, white; peduncle - 7 to 13 mm.; pedicel - 4 to 9 mm., slightly pubescent; calyx - 5-lobed, rarely 4, sepals 1 to 1.75 mm., linear, entire, acute; corolla - 5-lobed, rarely 4, 2.75 to 3.0 mm., lanceolate or ovate, acute, yellow green star; stamens - 5, filaments - 1 to 1.5 mm., slightly pubescent, anthers - 1.0 to 1.5 mm. long, oblong, connivent into a cone; ovary - ovoid, style - 1.6 to 2.8 mm., pubescent for ½ length, stigma - small, obscurely bilobed. Fruit - berry 5 to 8 mm. across, globose, bright orange red, accrescent calyx saucer shaped, 21 to 23 seeds and 2 to 5 stone grains per berry. Seeds - small, light yellow, discoid to slightly auricled.

Fls. & Frs. - Throughout the year.

SKT. 3, 6, 18, 22, 24.

Observed as a common weed of waste lands and cultivated fields.

Solanum purpureilineatum Sabnis & Bhatt, Bull. Bot. Surv. India 12(1-4): 258-260, 1970.

An erect or decumbent, annual herb, 20 to 40 cm. tall. Stem - with 3-4 corky ridges, tinged with purple, sparsely clothed with hairs. Leaves - simple, upto 10.7 cm. in length and 4.9 cm. in breadth, ovate, irregularly dentate, 2 to 4 teeth on either side, acute to subacute apex, truncate base, sparingly hairy on both the surfaces; petiole - 2 to 3.5 cm., slender. Flowers - in extra-axillary corymbose cymes, 6 to 8 flowered, white with single median stripe or median and lateral purple stripes; peduncle - 7 to 9 mm., filiform; calyx - 5-lobed rarely 4, 1.2-1.7 mm. long, oblong, obtuse with a purple spot in between; corolla - 5 or 4-lobed, petals 4-5 mm. long, ovate, acute, central star yellow green; stamens - 5, epipetalous, filaments - short 1.1 to 1.3 mm., covered with long glistening hairs; anthers - 1.3 to 1.8 mm. long, oblong, yellow, connivent into a coloumn; ovary - subglobose, style - 3 to 3.2 mm., exceeds the anthers, pubescent more than ½ length, stigma - globose-capitate. Fruit - berry, 5 to 6.5 mm. in diameter, globose, orange red, persistent calyx reflexed, 25 to 32 seeds and 2 to 5 stone grains per berry. Seeds - small, pale yellow, discoid-auricled, compressed.

Fls. & Frs. - September to March.

SKT. 11, 46, 47, 50.

Observed as a weed of shade near cultivated lands.

<u>Solanum nodiflorum</u> Jacq. Heiser, Jr. <u>et al</u>. Amer. Nat. 99 (909): 472, 1965.

An erect, annual herb, 70 to 90 cm. tall. Stem - without branches from the base, without rosettes when young, corky ridges not prominent. Leaves - simple, upto 13.5 cm. in length and 6.5 cm. in breadth, lanceolate-ovate, sinuate or with one tooth on each side, apex acute, cuneate at base, sparsely hairy on both the surfaces; petiole - upto 5 cm., slender, glabrous. Flowers - in subumbellate racemose cymes, 3-5 flowered, usually 4, occasionally peduncle bifurcated, than more than 7 flowers in each cyme, white; caylx - 5-lobed, rarely 4, lobes 1.25 mm. to 1.5 mm., oblong, obtuse; corolla - 5-lobed, rarely 4, lobes 3.25 mm., lanceolate, acute, yellow green central star; stamens - 5; filaments - short; anthers - 1.25 mm. oblong, yellow, connivent into a cone; ovary - ovoid; style - almost equalling the anthers, pubescent ½ length; stigma - obscurely bilobed. Fruit - berry, 5 to 8 mm. across, globose, shining purple black, calyx reflexed, seeds 40 to 50 per berry, however 72 seeds per berry are mentioned in referred flora. Seeds - small, pale yellow, discoid, compressed.

Fls. & Frs. - November to February.

SKT. 26, 27, 28.

Common weed of cultivated fields.

Coll. No. 27 showed long internodes.

Solanum nigrum L. Sp. Pl. 186, 1753; FBI. 4: 229; C. 2: 332; Bailey, 868; FGS. 1: 491.

An erect or decumbent annual herb, 50 to 80 cm. tall. Stem - smooth or slightly corky at base, much divaricately branched. Leaves - simple, 3.5 to 5.5 cm. in length and 1.7 to 2.8 cm. in breadth, ovate-lanceolate, entire or sinuate toothed, tooth shallow, 2-5 on either side, apex acute, cuneate at base; petiole - 9 to 11 mm. Flowers - in extra-axillary racemose-subumbellate cymes, 3 to 8 flowered, usually 5 or 6, white; peduncle - 8 to 12 mm., filiform, pedicel - short; calyx - 5-lobed, sepals oblong, entire, subacute to obtuse; corolla - 5-lobed, sometimes 4, 7 to 9 mm. across, petals about 4 mm. long, lanceolate, acute, central star yellow green; stamens - 5; filaments - short; anthers - 2.0 to 2.5 mm., oblong, yellow, connivent into a coloumn; ovary - subglobose, style - 2 to 2.5 mm. long, pubescent ½ length; stigma - obscurely bilobed. Fruit - berry, 6-7 mm. across, globose, dull black accrescent calyx saucer shaped, 30 to 42 seeds and 2-3 stone grains per berry. Seeds - small, 1.25 to 2.0 mm. across, light yellow, discoid, minutely pitted, compressed.

Fls. & Frs. - Throughout the year.

SKT. 2, 19, 30, 4.

Observed as a very common weed of wastelands especially near the cultivated fields.

Coll. No. 4 differs from others in showing red coloured veins on the upper surface of leaves.

<u>Solanum</u> <u>viarum</u> Dunal, DC. Prodr. 13: 240, 1852; Babu, JBNHS. 67: 610, 1971; Babu & Hepper, Kew Bull. 34, 2: 407-411, 1979.

<u>S</u>. <u>khasianum</u> C.B. Cl. var. <u>chatterjeanum</u> Sen Gupta, Bull. Bot. Surv. India 3: 413, 1961.

An erect, spinous, annual herb, 55 to 70 cm. tall. Stem - and branches - densely hirsute, aculeate with stout compressed, strongly recurved prickles mixed with short, straight ones. Leaves - big in size, broadly ovate, sinuately lobed, lobes ovate with acute to subacute apex, densely hirsute on the upper side, upto 16 mm. long sharp, straight prickles on mid-rib but short on lateral nerves; petiole - 5 to 7 cm., grooved, aculeate. Flowers - in racemose cymes, white; peduncle very short; pedicel - 10 to 12.5 mm. densely white-hirsute; calyx - 5-lobed, sepals 5 to 6.25 mm., ovate or triangular, acute to subacute, patently hairy; corolla - 5-lobed, petals 10 to 11.5 mm., ovate-cuneate, acute to acuminate, declinate at tip, central star green; stamens - 5, epipetalous, filaments - very short; anthers - 6.0 to 7.25 mm., oblong, yellow; ovary - ovoid, pubescent; style - glabrous; stigma - bilobed. Fruit - berry, large, more than 1 cm. in diameter, globose, yellow with purple spots, 20-25 seeds per berry. Seeds - 3 to 3.5 mm. across, brown, discoid, compressed (Pl.1:3).

Pl. 1:3 - Habit of *Solanum viarum*.

PL. 1: 3

Fls. & Frs. - November to February.

SKT. 25.

<u>Solanum</u> <u>trilobatum</u> L. Sp. Pl. 188, 1753; FBI. 4: 236-237; C. 2: 337; FGS. 1: 491-492.

A subscandent, more than one meter tall. Stem - slender, nearly glabrous, prickly, prickles arising from a broad triangular base with very sharp, compressed, recurved hooks. Branches - long, divaricate, prickles similar to stem. Leaves - simple, 4-5 cm. in length with almost same dimension in breadth, ovate or rotund-ovate, sinuate, 3-7 lobed, usually 5, obtuse, auricled, aculeate; petiole - 2.5 to 3.4 cm., aculeate. Flowers - in extra axillary cymes, 3 to 8 flowered, purple blue; peduncle - very short; pedicel - 1.2 to 2.6 cm., beset with short, strong, recurved prickles; calyx - 5-lobed, 3-5 mm., ovate-lanceolate, entire, acute, pubescent externally, occasionally prickly; corolla - 5-lobed, lobes oblong-lanceolate, acute, hairy outside, reflexed; stamens - 5, filament - short, anthers - narrowly oblong, yellow, connivent into a cone; ovary - ovoid-subglobose; style - glabrous, slightly curved, stigma - obscurely bilobed. Fruit - berry, 5-8 mm. in diameter, subglobose, scarlet red, persistent calyx deformed, a few seeds per berry. Seeds - 2.5 to 3.25 mm. across, brown, slightly pitted, compressed.

Fls. & Frs. - November to February.

SKT. 10, 48.

Observed as not so common weed of waste land, near hedges.

Solanum heterodoxum Dunal, DC. Prodr. 1852.

An erect, sub-herbaceous annual, about 60 cm. tall. Stem - terete, aculeate. Branches - subdichotomous, pilose, aculeate. Leaves - pinnatifid, pinna opposite and alternate, lobes irregular, pubescent on both the surfaces, sparsely aculeate on veins, membranous; petiole - 2-3.5 cm., aculeate. Flowers - in lateral, racemose, 3-5 flowered cymes, purple blue; peduncle - 2.5 to 3.3 cm.; pedicel - 0.8 to 1.2 cm., both peduncle & pedicel pilose and aculeate; caylx - 5-lobed, gamosepalous, campanulate or urn shaped, lobes 7 to 9 mm., lanceolate-linear, acute, aculeate, prickles as long as 4 mm.; corolla - 5-lobed, rotate, lobes 15-18 mm., ovate cuneate, cuspidate, deflexed, central star golden yellow, sparsely pubescent externally; stamens - 5, 4+1, 4 of approx. 7 mm. length and fifth always more than 10 mm., filaments - short, glabrous; anthers - oblong, declinate; ovary - glabrous; style - filiform, curved, stigma - not distinct. Fruit - berry, subglobose-ovoid, 5-7 mm., black, almost completely enclosed by accrescent calyx, calyx in fruit too aculeate, 10 to 12 seeds per berry. Seeds - 2.5 to 3.5 mm. across, black, hard.

Fls. & Frs. - November to February.

SKT. 34.

Source : Seeds received from 'The Director, Botanical Gardens, Copenhagen, Denmark'.

F A B A C E A E

FABACEAE

Tephrosia Pers. (nom. cons.)

Tephrosia strigosa (Dalz.) Santapau & Maheshwari, JBNHS. 54(3): 804, 1957; Saur. 1: 134; Fl. Del. 121; Bhandari, 131; FGS. 1: 250.

Macronyx strigosus Dalz. Hook. Kew Journ. 2: 35, 1850.

Tephrosia tenuis Wall. ex Dalz. & Gibs., FBI. 2: 111; C. 1: 344.

An erect, annual, small herb reaching about 28 to 30 cm. in height. Stem - slender, terete, covered with short adpressed hairs, caespitose. Branches - filiform, clothed with hairs. Leaves - simple, 35 to 40 mm. in length and 4 to 5 mm. in breadth, gradually narrowing towards base and apex, linear, apex long, apiculate, 18 to 20 lateral nerves on each side of the prominent midrib, covered with long silky hairs beneath; petiole - small, 1 to 33 mm., slender; Stipules - minute, subulate. Flowers - solitary axillary or geminate in axils, bluish yellow; pedicel - filiform, 0.8 to 1.2 cm. long; calyx - small, teeth lanceolate-subulate; corolla - petals 5, standard suborbicular, pubescent outside, wings obliquely obovate, keel glabrous; stamens - diadelphous; anthers - obtuse; style - upcurved, glabrous. Fruit - pod, 2-3 cm. long, linear, slightly curved at the tip, flattened, thinly pubescent, 6 to 9 seeds. per pod. Seeds - suborbicular, slightly turgid, brown, smooth.

Fls. & Frs. - August to October.

SKT. 63.

Observed as a wasteland weed among bushes.

<u>Tephrosia jamnagarensis</u> Santapau Proc. Nat. Inst. Sci. India, 24, 13: 133, t. 1, 1958; FGS. 1: 250.

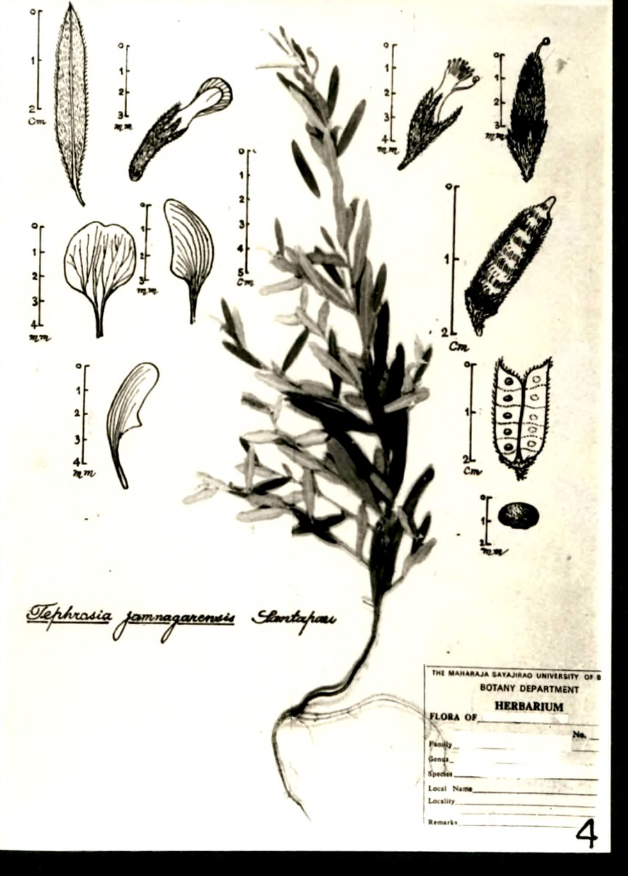
An erect, much branched annual undershrub. Stem - suffructicose, covered with appressed hairs. Branches - angular. Leaves - simple, 45 to 53 mm. in length and 7 to 9 mm. in breadth, gradually tapering at both the ends, linear, apex subobtuse or apiculate, covered with long appressed silky hairs beneath and on the margins, 24-30 lateral nerves on each side of midrib; petiole - small, 1.5 to 3 mm. long; stipules - subulate, upto 3.5 mm. in length. Flowers - solitary axillary or in pairs almost in all axils; pedicel - small, hairy; calyx - lobes subequal, subulate; corolla - petals bluish yellow, standard long clawed, suborbicular, pubescent outside; stamens - diadelphous; anthers - subobtuse; style - slightly curved; stigma - penicillate. Fruit - pod, 2 to 3 cm. long, linear, oblique at both ends, compressed, patently hairy, 5-7 seeds per pod. Seeds - small, reniform, dull brown (Pl.1:4).

Fls. & Frs. - July to September.

SKT. 64.

A less frequent weed of wastelands near cultivated fields.

Pl. 1:4 - Habit of *Tephrosia jamnagarensis*.


Tephrosia jamnagarensis Santapau
THE MAHARAJA SAYAJIRAO UNIVERSITY OF B
BOTANY DEPARTMENT
HERBARIUM
FLORA OF
No.
Family
Genus
Species
Local Name
Locality
Remarks
4

PL. I:4

<u>Tephrosia</u> <u>uniflora</u> Pers. subsp. <u>petrosa</u> (Blatt. & Hall.) Gillet & Ali, Kew Bull. 114, 1958; Bhandari, 132; FGS. 1: 251.

<u>T</u>. <u>petrosa</u> Blatt. & Hall. JBNHS. 26(1): 239, 1918.

<u>T</u>. <u>pauciflora</u> Grahm. ex Baker, FBI. 2: 114; C. I: 348.

A profusely branched, perennial herb. Stem - suffructicose. Branches - diffuse or procumbent, thin, angular, adpressedly pubescent. Leaves - pinnately compound, as many as 3 to 9 leaflets per leaf, usually 5, terminal leaflet always largest one, leaflets obovate, entire, apex mucronate, glabrous above and densely hairy with silvery, patent hairs beneath and on margins, 9-10 lateral nerves on each side of the midrib; petiole - 1-2.5 cm. long, hairy; stipules - subulate, 5-6 mm. long, conspicuously hairy. Flowers - axillary solitary or geminate; pedicel - small, hairy; calyx - 3-4 mm. long, subulate; corolla - pale pink with purple tinge, standard, quite broad, 9 mm. long, suborbicular; stamens - diadelphous; ovary - densely hairy; style - flattened; stigma - penicillate. Fruit - pod, 3 to 4.25 cm. long, linear, attenuated at the base, covered with silvery white, patent hairs, 7-9 seeds per pod. Seeds - reniform, somewhat compressed, light but dirty yellow with dark colour patches.

Fls. & Frs. - August to February.

SKT. 65.

A not so common plant of dry region.

Tephrosia subtriflora Hochst. ex Baker, Fl. Trop. Afr. 2: 117, 1871; Gillet & Ali, Kew Bull. 113, 1958.

T. multiflora Blatt. & Hall. JBNHS. 26(1): 239, 1918.

A small, herb reaching 42 to 50 cm. height. Stem - suffructicose, woody, darkly tinged with purple, clothed with short, white hairs throughout. Branches - erect and procumbent, angular. Leaves - pinnately compound, 3-9 leaflets, usually less leaflet numbered leaves are near the base, terminal leaflet is always the largest and first pair is always smallest, leaflets elliptic, apex apiculate, glabrous above, densely covered by silky grey hairs beneath 19-20 lateral nerves on each side of the midrib; petiole - 1.5 to 2.5 cm. long, grooved on the upper side, hirsute; stipules - 3 nerved, slightly reflexed, hairy outside. Flowers - axillary fascicles, 2 to 6 rarely 7 flowers in fascicles; calyx - 2 to 3 mm. long, teeth almost equal to tube, hairy; corolla - pale pink, standard 6-7 mm. long, hirsute outside; ovary - clothed by short glistening white hairs; style - glabrous, slightly compressed; stigma - knobed or penicillate. Fruit - pod, 3 to 3.4 cm. long, linear, shortly but obliquely triangular at apex, turgid, pubescent, 4-7 seeds per pod. Seeds - ovoid reniform, dirty yellow with dark coloured blotches.

Fls. & Frs. - July to November.

SKT. 66.

In this taxon, viviparous germination of few seeds was noticed in pods on plants itself in the month of August. However, when transferred to pots, such seeds did not grow further to develop into mature plants.

Tephrosia villosa (L.) Pers. Syn. Pl. 2: 329, 1807; FBI. 2: 113; C. 1: 347; Bhandari, 133; FGS. 1: 251.

Caracca villosa L. Sp. Pl. 752, 1753.

Tephrosia hirta Ham. Trans. Linn. Soc. 13: 546, 1822; Santapau, Saur. 1: 135, 1962.

An annual, erect, gregarious bushy herb. Stem and branches - angular, densely covered with greyish, long adpressed hairs. Leaves - pinnately compound, 11 to 17 leaflets per leaf, usually 13 or 15, 1.2 to 2.0 cm. in length and 0.5 to 1.0 cm. in breadth, oblanceolate, apex mucronate, occasionally rounded, glabrous above, densely hairy beneath, 11-13 lateral nerves on each side of the midrib; petiole - 0.8 to 1.2 cm. long, hairy; stipules - 3 to 4 mm. long, densely pubescent outside and on margin. Flowers - in lax elongated racemes, lower flowers in fascicles; pedicel - short; bract - linear-subulate, persistent, plumose; calyx - 8-9 mm., covered with woolly hairs outside; corolla - standard large, pale red or white, suborbicular, silky hairs on backside; style - compressed, glabrous; stigma - penicillate. Fruit - pod, 2.8 to 3.2 cm. long, falcately curved upwards, densely and persistently velvety all over with spreading fulvous hairs, 6 to 8 seeds per pod. Seeds - reniform, light brown with dark brown coloured blisterous patches.

Fls. & Frs. - October to February.

SKT. 9, 20, 52.

Commonly observed as roadside and wasteland weed near pond, ditch etc.

<u>Tephrosia</u> <u>falciformis</u> Ramaswamy, Journ. Asiat. Soc. Bengal 12: 125, 1916; Bhandari, 129.

A profusely branched, undershrub, 30 to 35 cm. tall. Stem and branches - angular, densely pubescent. Leaves - pinnately compound, 5-17 leaflets per leaf, usually 13 or 15, terminal leaflet slightly larger, leaflets 2.5 to 4.0 cm. long and 0.4 to 0.6 cm. broad, narrowly oblong, apex mucronate, argenteó canescent with adpressed hairs on both surfaces, 12-15 lateral nerves on each side of the midrib; petiole - 2 to 3 cm. long, conspicuously pulvinus ; stipules - 3 mm. long, linear, persistent. Flowers - lax, terminal racemes, lower flowers usually geminate, one with long pedicel and other with short; calyx - 4 to 5 mm. long, tube and teeth almost equal in size, covered with white, silky hairs outside; corolla - standard large, 8 to 10 mm. in length and almost same in breadth, orbicular cordate, covered with silvery white hairs on outside; style - flattened; stigma - penicillate. Fruit - pod, densely pubescent all over, tip mucronate. Seeds - obscurely reniform.

Fls. & Frs. - July to October.

SKT. 67.

Plant grown in local conditions grew well vegetatively and also flowered. But failed to yield fruits and seeds.

<u>Tephrosia</u> <u>wallichii</u> Grahm. Wall. Cat. No. 5640, 1831-32 (<u>nom</u>. <u>nud</u>.) ex Fawcett & Rendle, Journ. Bot. 55: 35, 1917; Bhandari, 134.

<u>T</u>. <u>purpurea</u> (ex parte) FBI. 2: 112.

A small, erect, herb. Stem - woody at base with 3-7 spreading branches, covered with greyish pubescence. Branches - angular, covered with short, dense, grey hairs. Leaves - pinnately compound, 11-19 leaflets per leaf, usually 15, leaflets 20-25 mm. in length and 7 to 9 mm. in breadth, obovate, shortly mucronate, occasionally notched with mucronate tip, glabrous above, covered with long adpressed silky hairs beneath and on margins, 8-10 lateral nerves on each side of the midrib; petiole - short; stipules - 3 to 5 mm., subulate. Flowers - lax racemes, as long as 10 cm. many flowers at each node; calyx - tube 2 mm. long, teeth 2-3 mm. long, densely pubescent; corolla - bright pink, standard recurved, pubescent outside; style - glabrous; stigma - knobed, penicillate. Fruit - pod, spreading on all sides, 0.4 to 0.5 cm. long, slightly torulose, depressed between the seeds, with spreading pubescence, 6-7 seeds per pod. Seeds - reniform, pale greyish brown with blackish irregular blotches, smooth.

Fls. & Frs. - August to December.

SKT. 53, 68.

Both the collected populations did not flower and fruit.

Tephrosia candida DC. Prodr. 2: 240, 1825; FBI. 2: 111; FGS. 1: 247.

A small, much-branched, herb. Stem - suffruticose. Branches - angular, covered with adpressedly short, grey hairs. Leaves - pinnately compound, 7-15 leaflets per leaf, usually 11, 13, leaflets 12 to 15 mm. long and 7 to 9 mm. broad, lanceolate-oblanceolate, mucronate, glabrous above, covered with short, grey pubescence beneath, 11-12 lateral nerves on each side of the midrib; petiole - 3 to 5 mm., hairy; stipules - small, subulate. Flowers - terminal or leaf-opposed, few flowered lax racemes; pedicel - slender, hairy; calyx - 3 to 5 mm., teeth as long as tube, thinly covered by hairs outside; corolla - white, standard suborbicular, long clawed, hairy outside; style - glabrous, stigma penicillate. Fruit - pod, 3.5 to 3.8 cm. long, curved near the tip, slightly depressed between the seeds, almost smooth, 6-7 seeds per pod. Seeds - reniform, pale brown with dark brown patches, smooth.

Fls. & Frs. - August to December.

SKT. 62.

<u>Tephrosia purpurea</u> (L.) Pers. Syn. Pl. 2: 329, 1807; FBI. 2: 112; C. 1: 346; Bhandari, 131; FGS. 1: 249.

<u>Caracca purpurea</u> L. Sp. Pl. 1: 752, 1753.

A copiously branched, erect, perennial herb, 60 to 90 cm. tall. Stem - slender, terete, glabrescent. Branches - spreading on all the sides. Leaves - pinnately compound, 13 to 19 leaflets per leaf, usually 13 to 15 rarely, more than 19, leaflet 20-22 mm. long, oblanceolate, obtuse, mucronate, glabrescent above and thinly clothed with silky hairs beneath, 10-12 lateral nerves on each side of the midrib; petiole - 0.9 to 1.5 cm. long, grooved on the upper side; stipules - small, mostly linear but occasionally subulate, sometimes reflexed. Flowers - terminal or leaf-opposed lax racemes, lower flowers of the raceme fascicled; pedicel - 5-8 mm. long, slender; bract - linear; calyx - 6 to 8 mm. long, teeth and tube almost equal in length, thinly covered by silky hairs; corolla - purple pink, standard large, 8-10 mm. broad and almost same in length, pubescent outside; style - flattened, glabrous, stigma - penicillate. Fruit - pod, 3.5 to 4.2 cm. long, linear, slightly curved mucronate, at first thinly hairy but glabrescent when mature, 5 to 8 seeds per pod. Seeds - reniform, dull pale brown in colour.

Fls. & Frs. - Throughout the year.

SKT. 56 L 61 L 5

Commonly observed as roadside weed in open areas or fallow fields. Although flowering and fruiting throughout the year but profuse during July to November.

Tephrosia pumila (Lamk.) Pers. Syn. Pl. 2: 330, 1807; Fl. Del. 121; Brumitt, Bolteim Soc. Brot. 41 (2-A): 242, 1967; FGS. 1: 249.

Galega pumila Lamk. Ençycl. 2: 599, 1788.

Tephrosia purpurea (L.) Pers. var. pumila (Lamk.) Baker, FBI. 2: 113; C. 1: 347.

This species very much resembles T. purpurea in general morphology. However, it differs from it in few features.

A gregariously branched herb. Stem - slender, terete, covered with fine hairs. Branches - spreading, hairy. Leaves - pinnately compound, 11 to 15 leaflets per leaf, usually 13, leaflets 1.5 to 1.8 cm. long and 4 to 6 mm. broad, oblanceolate, obtuse, mucronate, clothed with silky hairs beneath, 6-8 lateral nerves on each side of the midrib; petiole - 1.2 to 1.9 cm., slender, pubescent; stipules - small, lanceolate. Flowers - leaf-opposed raceme, few flowered, racemes densely hairy; pedicel - short, slender, thickly pubescent; calyx - 2 to 3.5 mm. long, thinly pubescent; corolla - rosy pink, standard long clawed, suborbicular, pubescent outside; style - flattened, glabrous, stigma - penicillate. Fruit - pod, 2.2 to 2.8 cm. long, linear, appressedly hairy, 5-9 seeds per berry. Seeds - oblong- blackish brown, somewhat compressed.

Fls. & Frs. - August to December.

SKT. 1, 57.

A not so common, diffused herb of wastelands and roadsides.

Tephrosia hamiltonii Drumm.; Gamble, Fl. Mad. 1: 320, 1918; FGS. 1: 248.

T. purpurea Baker, FBI. 2: 112 (pro parte); C. 1: 346.

This species resembles T. purpurea in general morphology. However, it differs from it in few features.

A much branched, annual undershrub. Stem - thinly hairy. Branches - spreading on all the sides, zig-zag, angular, covered with greyish white pubescence. Leaves - pinnately compound, 7 to 13 leaflets per leaf, 12 to 23 mm. in length and 9 to 13 mm. in breadth, obovate to oblanceolate, shortly mucronate or notched with small mucronate tip, glabrous above and thinly covered with hairs beneath; petiole - small, stipule - subulate. Flowers - in extra axillary or leaf-opposed lax racemes, larger in size than T. purpurea; pedicel - 4 to 7 mm., slender, hairy; bracts - linear; calyx - tube and teeth almost equal in length, narrowly deltoid, covered with fine silky hairs outside; corolla - bright purple red, standard large, 9 X 10 mm. in size, suborbicular or cordate, long clawed, pubescent outside; style - flattened, not bearded, stigma penicillate. Fruit - pod, 2.5 to 3 cm. long, linear, compressed when mature, covered with villous tomentum, 5-9 seeds per pod. Seeds - oblong, brownish in colour with dark coloured patches.

Fls. & Frs. - August to December.

SKT. 58.

A rare weed seen only in open lands of Laxmi Vilas Palace of Baroda along with T. purpurea.

Psoralea L.

Psoralea corylifolia L. Sp. Pl. 764, 1753; FBI. 2: 103; C. 1: 341; FGS. 1: 236.

An erect, annual herb, 40 to 54 cm. in height. Stem and branches - grooved, thinly covered with long, greyish hairs, brown to black glands conspicuous. Leaves - simple, 3.5 to 6.5 cm. in length and 2 to 3.2 cm. in breadth, ovate-broad elliptic, inciso-dentate, rounded with mucronate at the apex, clothed with greyish white hairs on both the surfaces; nigro-punctate; petiole - 2.3 to 3.0 cm., nigro-punctate; stipules - lanceolate, persistent. Flowers - in dense, axillary, many-flowered racemes; peduncle - long, hairy; pedicel - very short; calyx - 3 to 4 mm., upper teeth linear-lanceolate, lower one ovate, pubescent, nigro-punctate; corolla - bluish purple, 7 to 8 mm., standard orbicular, long clawed; stamens -

upper stamen more or less connate with others; anthers - small; ovary - sessile; style - filiform, curved above. Fruit - pod, small, 3.5 to 5 mm., ovoid oblong, compressed, mucronate, glabrous, one-seeded. Seeds - ovoid-oblong, smooth, black, closely adhering to the pericarp.

Fls. & Frs. - August to December.

SKT. 7, 51.

A common weed of wasteland. Also seen along roadsides.

*****

CYTOLOGICAL OBSERVATIONS

S O L A N A C E A E

CYTOLOGICAL OBSERVATIONS

In the present investigation based on the length and position of centromere, chromosomes are classified into number of 'types'. This is done with a view to describe the karyotype and represent the same by karyotypic formulae. This would also help in better understanding of karyotypes of the taxa analysed and their relationships at intraspecific, interspecific as well as at intrageneric levels.

For the members of Solanaceae adopted categorisation is as follows :

1. Chromosomes - 4 μ or more in length
   - 1.1 With nearly submedian centromere .... A
2. Chromosomes - 3 μ to less than 4 μ in length
   - 2.1 With nearly median centromere .... B
   - 2.2 With nearly submedian centromere C
3. Chromosomes - 2 μ to less than 3 μ in length
   - 3.1 With nearly median centromere .... D
   - 3.2 With submedian centromere .... E
   - 3.3 With nearly submedian centromere .... F
4. Chromosomes - less than 2 μ in length
   - 4.1 With nearly median centromere .... G
   - 4.2 With nearly median centromere .... H

5. Isochromosome Ic

Superscript

S - denotes satellited chromosome.

S' - denotes chromosome with secondary constriction on long arm.

Nicandra physalòdes (L.) Gaertn.

The first chromosome count for the species was made by Vilmorin & Simmonet (1928), who reported 2n = 20 for the somatic complement. Subsequent studies by Janaki Ammal (1932), Darlington & Janaki Ammal (1945), Delay (1947), Gottschalk (1954) and Venkateshwarlu & Rao (1962, 1963) have confirmed the earlier reports of 2n = 20. Darlington & Janaki Ammal (1945) have also found 2n = 19 and have also observed 2n = 40 in the artificially induced tetraploid plants. However, Sinha (1951) has reported 2n = 21 for the species. Populations analysed presently, showed 2n = 19 (Coll. No. 16) and 2n = 20 (Coll. Nos. 8, 21). Janaki Ammal (1932) and all other subsequent workers have reported the existence of 1 or 2 isochromosomes in the somatic complement of the species.

Coll. No. 16 :

Karyotype formula : $2n = 19 = D_2+F_2^{S'}+Ic_1+F_{12}+H_2$

(Table 2:1)

Somatic complement of the species is comprised of 19 chromosomes. 8 pairs of chromosomes with nearly submedian centromere are distributed in F & H - types. There is only one pair with nearly median centromere and is represented by D-type. The chromosome length varies between 1.452 to 2.926 μ. The

Table 2:1. Details of the karyotype analysis of <u>Nicandra physalodes</u> (L.) Gaertn. (Coll. No. 16).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	Arm Ratios R_2	Relative length	Centromere	Type
1, 2	0.685 +1.162	+ 1.079	= 2.926	0.58	1.71	100	nsm	$F^{S'}$
3	1.245	+ 0.747 + 0.705	= 2.697	-	-	92	-	Ic
4, 5	1.805	+ 0.851	= 2.656	0.47	2.12	90	nsm	F
6, 7	1.826	+ 0.830	= 2.656	0.45	2.20	90	nsm	F
8, 9	1.639	+ 0.768	= 2.407	0.46	2.13	82	nsm	F
10,11	1.577	+ 0.768	= 2.345	0.48	2.05	80	nsm	F
12,13	1.515	+ 0.788	= 2.303	0.52	1.92	78	nsm	F
14,15	1.370	+ 0.871	= 2.241	0.63	1.57	76	nm	D
16,17	1.577	+ 0.560	= 2.137	0.35	2.81	73	nsm	F
18,19	0.975	+ 0.477	= 1.452	0.48	2.04	49	nsm	H
	15.376	8.444	23.820					

L/S = 2.01

Mean length = 1.25 μ

T F % = 35.44%

Karyotype formula = 2n = 19 = $D_2 + F_2^{S'} + Ic_1 + F_{12} + H_2$

Pl. 2:1

Nicandra physalodes

Coll. No. 16:

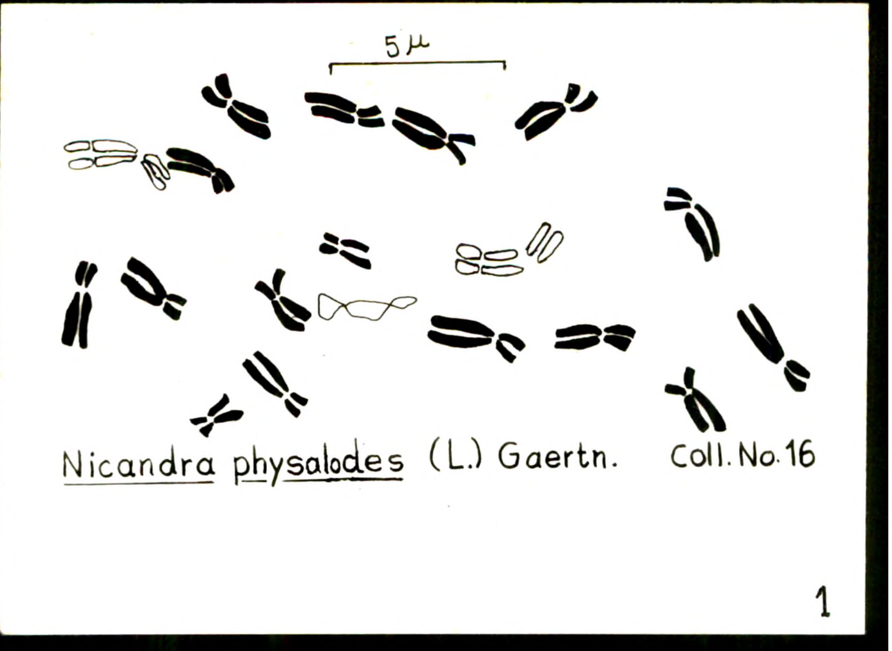
(Mitosis)

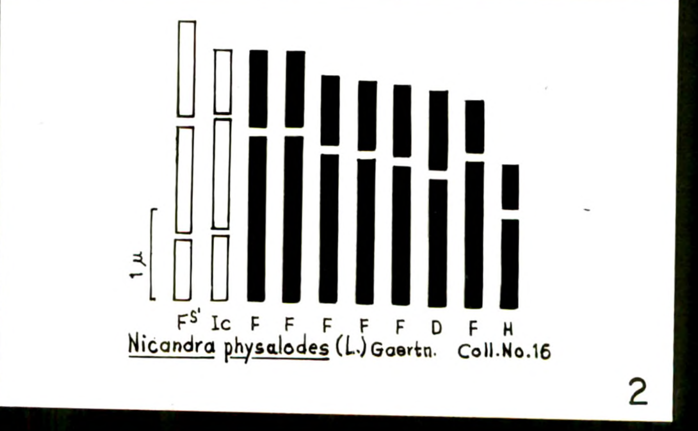
Fig. 1 - Camera lucida drawing of somatic metaphase plate.

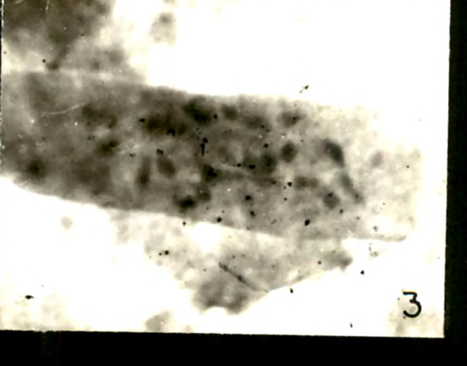
Fig. 2 - Idiogram.

Fig. 3 - Photomicrograph of somatic metaphase.

Contd....


5 μ
Nicandra physalodes (L.) Gaertn. Coll. No. 16
1


1 μ
FS' Ic F F F F F D F H
Nicandra physalodes (L.) Gaertn. Coll. No. 16
2


3

PL. 2:1

complement is rather characteristic in showing the presence of only one isochromosome. But for one pair of H-type of short chromosomes, remaining all are medium sized. The longest pair ($F^{S'}$-type) of the complement has secondary constriction on its long arms. The karyotype in general shows smooth gradation and the same is evident in the idiogram (Figs. 1, 2, 3). The values for TF% and L/S ratio are 35.44% and 2.01 respectively, which point towards the asymmetrical and smoothly graded nature of the complement.

Coll. No. 8 :

Karyotype formula : $2n = 20 = D_2+F^{S'}_2+Ic_2+F_8+G_4+H_2$

(Table 2:2)

In the somatic metaphase plate of this collection 20 chromosomes are seen. 9 pairs of chromosomes are autosomes and one pair of isochromosome. The 9 pairs of autosomes are represented by 6 pairs with nearly submedian centromeres (F & H -types) and remaining 3 pairs with nearly median centromeres (D & G-types). One pair of $F^{S'}$-type has secondary constrictions on its long arms. The total chromatin length determined for the complement is 21.221 μ with a mean length of 1.25 μ. TF% and L/S ratio determined for this population are 37.34% and 2.01 respectively (Figs. 4, 5, 6).

Pl. 2:2

Nicandra physalodes

Coll. No. 8 :

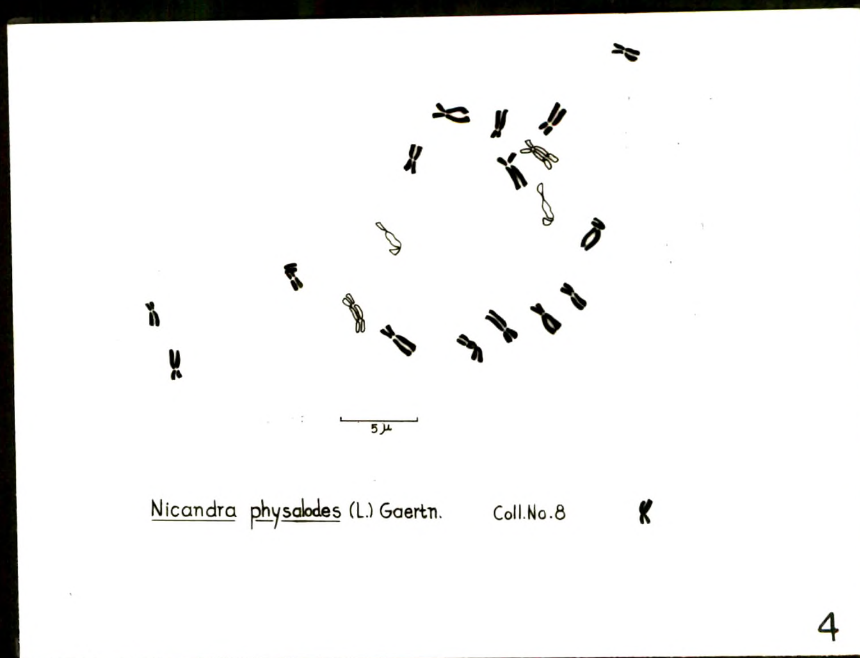
(Mitosis)

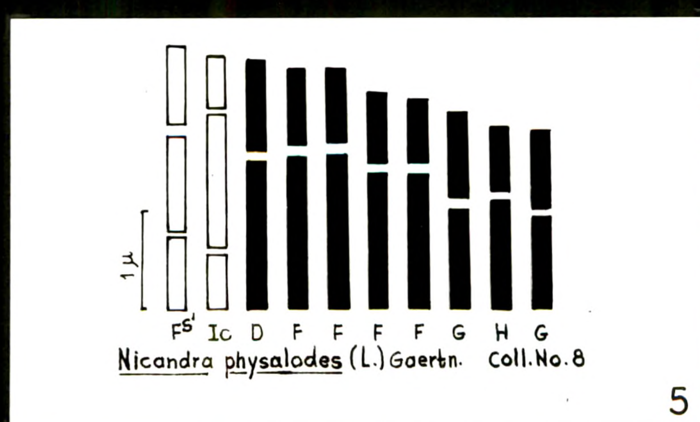
Fig. 4 - Camera lucida drawing of somatic metaphase plate.

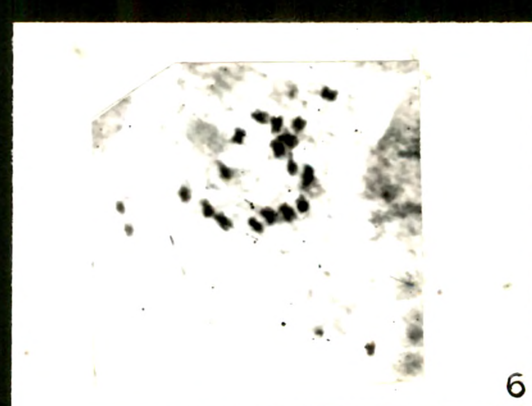
Fig. 5 - Idiogram.

Fig. 6 - Photomicrograph of somatic metaphase plate.

Contd....


5 μ
Nicandra physalodes (L.) Gaertn. Coll.No.8
4


1 μ
FS' Ic D F F F F G H G
Nicandra physalodes (L.) Gaertn. Coll.No.8
5


6

PL. 2:2

Table 2:2. Details of the karyotype analysis of Nicandra physalodes (L.) Gaertn. (Coll. No. 08).

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	0.747 +0.933	+ 0.809	= 2.489	0.48	2.08	100	nsm	$F^{S'}$
3, 4	1.328	+ 0.560 + 0.519	= 2.407	-	-	96		Ic
5, 6	1.473	+ 0.913	= 2.386	0.61	1.61	95	nm	D
7, 8	1.535	+ 0.788	= 2.323	0.51	1.94	93	nsm	F
9,10	1.556	+ 0.747	= 2.303	0.47	2.08	92	nsm	F
11,12	1.369	+ 0.726	= 2.095	0.53	1.88	84	nsm	F
13,14	1.369	+ 0.643	= 2.012	0.46	2.13	80	nsm	F
15,16	1.016	+ 0.850	= 1.866	0.83	1.19	74	nm	G
17,18	1.079	+ 0.622	= 1.701	0.57	1.73	68	nsm	H
19,20	0.892	+ 0.747	= 1.639	0.83	1.19	65	nm	G
	13.297	7.924	21.221					

L/S = 1.51

Mean length = 1.06 μ

T F % = 37.34%

Karyotype formula = 2n = 20 = $D_2 + F_2^{S'} + Ic_2 + F_8 + G_4 + H_2$

Coll. No. 21:

Karyotype formula : $2n = 20 = F_2^{S'}+Ic_2+F_4+G_6+H_6$

(Table 2:3)

This collection resembles the preceding one in having 2n = 20, 6 pairs of chromosomes with nearly submedian centromere (F & H-types), 3 pairs with nearly median centromere (G-type) and only one pair of isochromosome (Ic-type) in the complement. The length of the chromosomes in the complement varies between 1.245 to 2.407 μ with a mean length of 0.906 μ. The determined values of L/S ratio, TF% are 1.93 and 35.59% respectively. Except for slight abruptness, idiogram is more or less smoothly graded (Figs. 7, 8, 9).

3 populations of Nicandra physalodes analysed, reveal gross similarity in their karyotypes in having more or less same types of chromosomes, a pair of secondarily constricted chromosome. Moreover, values for absolute length, mean length and L/S ratio for the 3 populations are also quite comparable. The Indian population (Coll. No. 16) is having only one isochromosome while other two obtained from Botanical Gardens of Kew and Copenhagen, have 2 isochromosomes in their complements (Table 2:4). In absence of striking morphological differences in the 3 populations, minor structural differences in the karyotype indicate the presence of cytotypes.

In this species, because of the presence of isochromosome,

Pl. 2:3

Nicandra physalodes

Coll. No. 21:

(Mitosis)

Fig. 7 - Camera lucida drawing of somatic metaphase plate.

Fig. 8 - Idiogram.

Fig. 9 - Photomicrograph of somatic metaphase plate.

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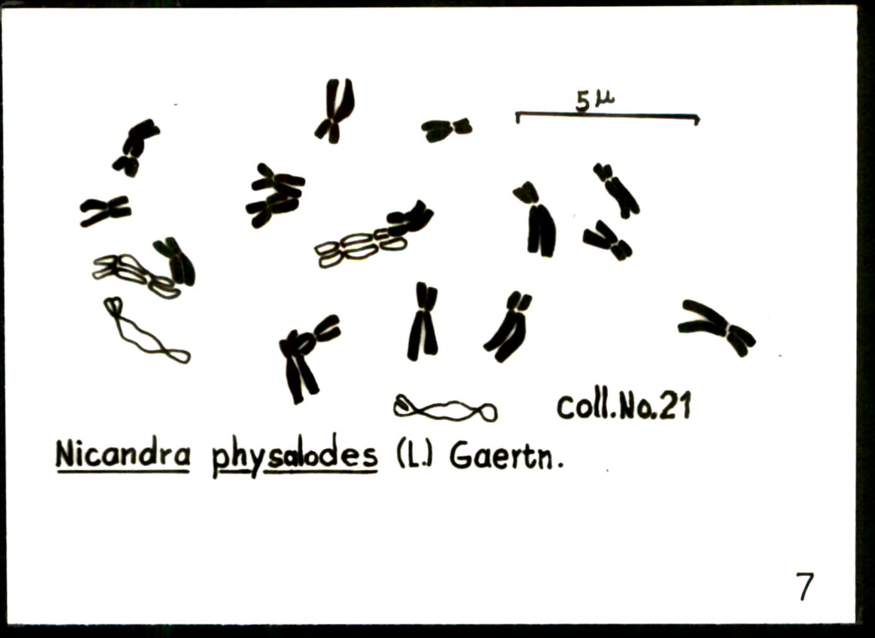
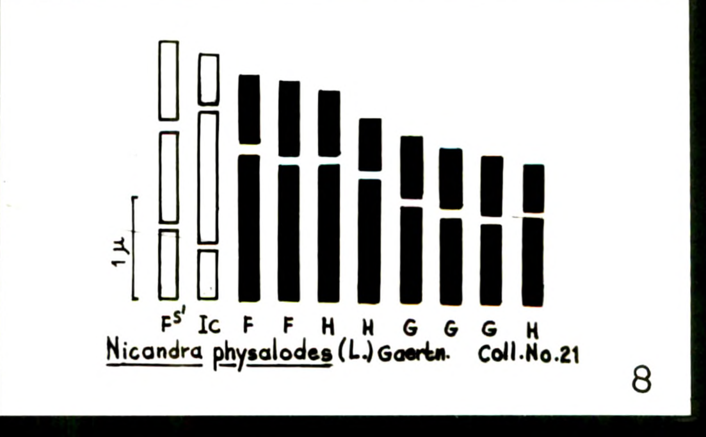
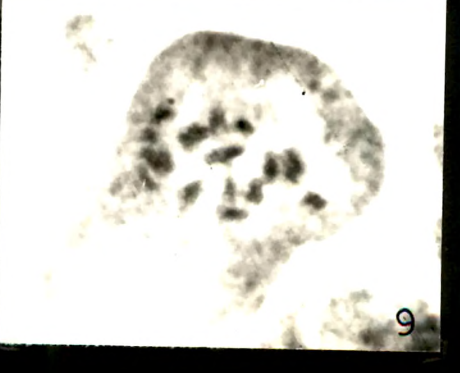

5μ
Coll.No.21
Nicandra physalodes (L.) Gaertn.
7


1μ
FS' Ic F F H H G G G H
Nicandra physalodes (L.) Gaertn. Coll.No.21
8


9

PL. 2:3

Table 2:3. Details of the karyotype analysis of *Nicandra physalodes* (L.) Gaertn. (Coll. No. 21).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1,2	0.706 + 0.913	+ 0.788	= 2.407	0.49	2.05	100	nsm	$F^{S'}$
3,4	1.328	+ 0.519 + 0.519	= 2.366	-	-	98	-	Ic
5, 6	1.452	+ 0.664	= 2.116	0.45	2.19	88	nsm	F
7, 8	1.349	+ 0.718	= 2.067	0.53	1.88	85	nsm	F
9,10	1.349	+ 0.622	= 1.971	0.46	2.17	81	nsm	H
11,12	1.203	+ 0.498	= 1.701	0.41	2.41	70	nsm	H
13,14	0.934	+ 0.581	= 1.515	0.62	1.60	62	nm	G
15,16	0.830	+ 0.581	= 1.411	0.70	1.42	58	nm	G
17,18	0.788	+ 0.552	= 1.340	0.70	1.42	55	nm	G
19,20	0.830	+ 0.415	= 1.245	0.50	2.00	51	nsm	H
	11.682	6.457	18.139					

L/S = 1.93

Mean length = 0.91 μ

T F % = 35.59%

Karyotype formula = 2n = 20 = $F_2^{S'} + Ic_2 + F_4 + G_6 + H_6$

Table 2:4. Comparison of the somatic chromosomes of different populations of _Nicandra physalodes_ (L.) Gaertn.

Coll. No.	Somatic number (2n)	nsm Types F	nsm Types H	nm Types D	nm Types G	Iso-chromosome	Sec.const. Chromosome $F^{S'}$	Absolute length in μ	Mean length in μ	L/S
16	19	14	2	2	-	1	2	23.820	1.25	2.01
08	20	10	2	2	4	2	2	21.221	1.06	1.51
21	20	6	6	-	6	2	2	18.139	0.91	1.93

meiotic behaviour is quite interesting. Population having 2n = 19 during first meiotic division show unequal distribution at anaphase I forming 2 groups of 10 and 9 (Fig. 10). At diakinesis 9 regular bivalents and one isochromosome having distinct knobs at the 2 poles lying nearer the nucleolus can be seen (Figs. 11, 12). At late diakinesis in comparison to other chromosomes, early separation of few bivalents is also observed in a few PMCs (Fig. 13). At metaphase I isochromosome is distinct. It is observed lying either nearer or away from the metaphase plate (Figs. 14, 15). Presence of laggards is also noticed. Presence of ~~of~~ persistent nuclei at anaphase I (Fig. 16) and abnormal orientation of metaphase plates (Fig.17) are the abnormalities noticed in this population having 2n = 19. In spite of all the abnormalities mentioned above, the calculated fertility is quite high (94.77%).

Other 2 populations having 2n = 20, in their meiotic behaviour reveal the occurrence of 10 distinct bivalents. Among these bivalents, isochromosome bivalent appears distinct and usually lie nearer the nucleolus (Figs. 18,19,23,24,25). Equal distribution of chromosomes is noticed at anaphase I (Figs. 21, 26), Occurrence of non congressional bivalent at metaphase I (Fig. 20) and laggards at metaphase II (Fig. 32), perhaps result in the formation of 5 groups of chromosomes at telophase II (Fig. 33). Non synchronised movements of bivalents (Figs. 29, 31), association of bivalents (Fig. 30) at metaphase I

Pl. 2:4

Nicandra physalodes

Coll. No. 16 :

(Meiosis)

Fig. 10 - PMC showing unequal distribution at anaphase I.

Fig. 11 - " " 9 bivalents and one isochromosome near the nucleolus at diakinesis.

Fig. 12 - " " 9 distinct bivalents and an isochromosome near the nucleolus.

Fig. 13 - " " early separation of few bivalents at late diakinesis.

Fig. 14 - " " metaphase I, note the isochromosome lying away from the equatorial plate.

Fig. 15 - " " isochromosome lying nearer the metaphase plate.

Fig. 16 - " " persistent nuclei at anaphase I.

Fig. 17 - " " abnormal orientation at metaphase II.

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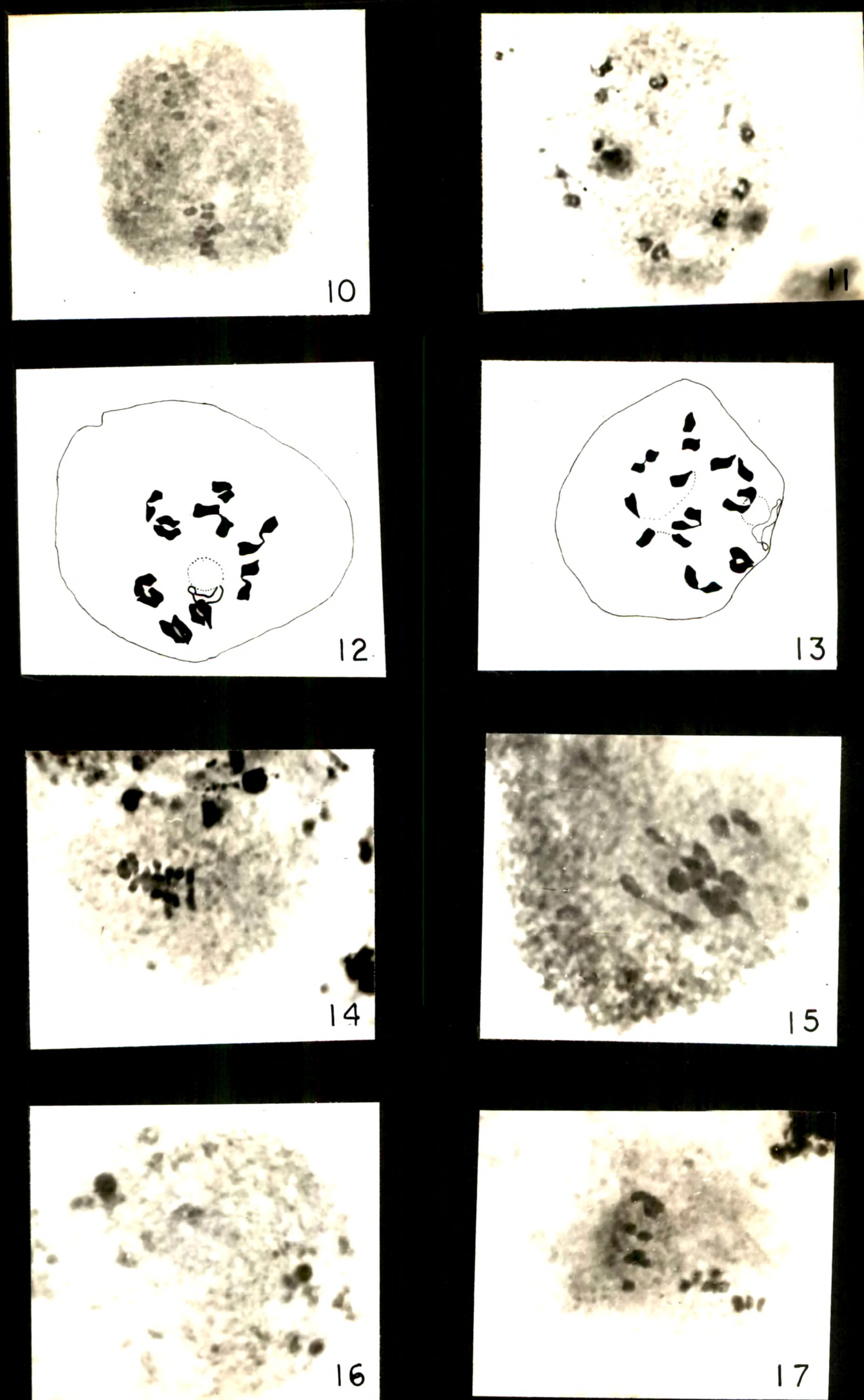

PL. 2:4

Pl. 2:5

Nicandra physalodes

Coll. No. 8 :

(Meiosis)

Fig. 18 - PMC showing 10 distinct bivalents at diakinesis.

Fig. 19 - " " diakinesis. Note isochromosome and one normal bivalent near the nucleolus.

Fig. 20 - " " non congressional isochromosomes at metaphase I.

Fig. 21 - " " equal distribution (10:10) of chromosomes at metaphase II (Polar view).

Fig. 22 - " " Telophase I.

Coll. No. 21 :

Fig. 23 - " " 10 distinct bivalents at late diakinesis.

Fig. 24 - " " Camera lucida drawing of Fig. 23.

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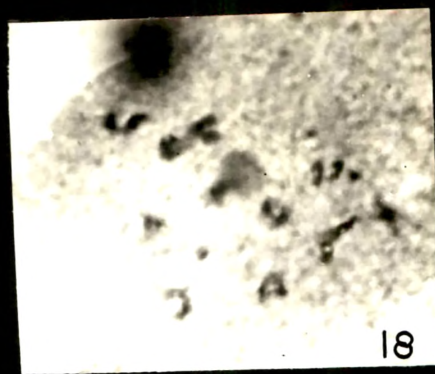

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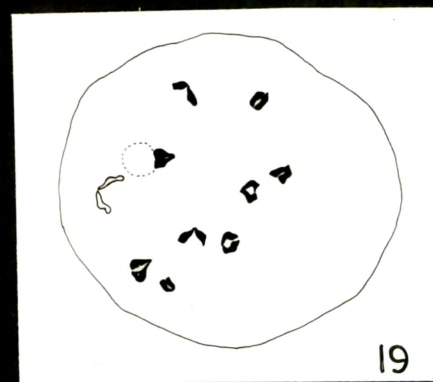

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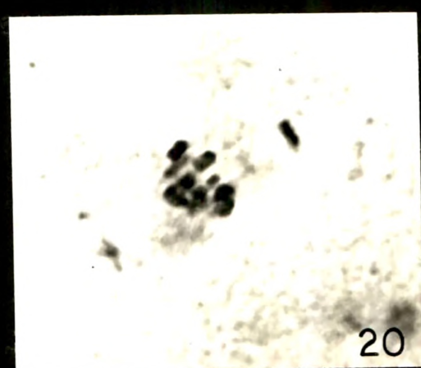

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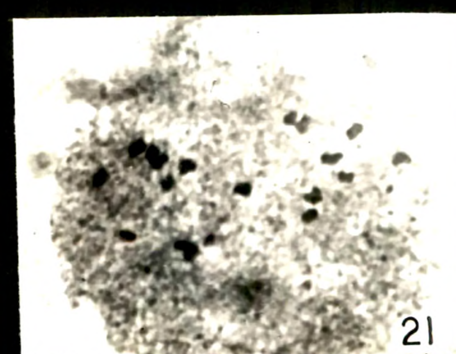

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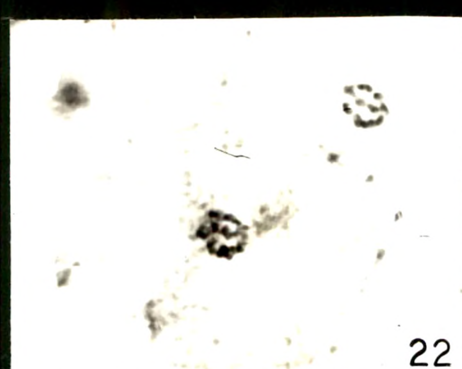

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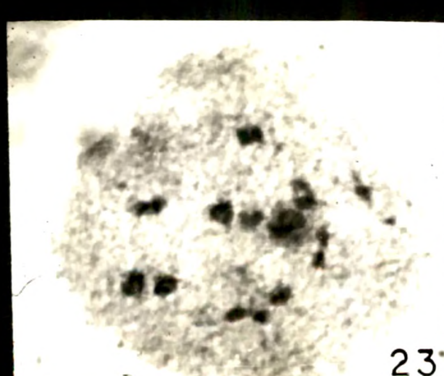

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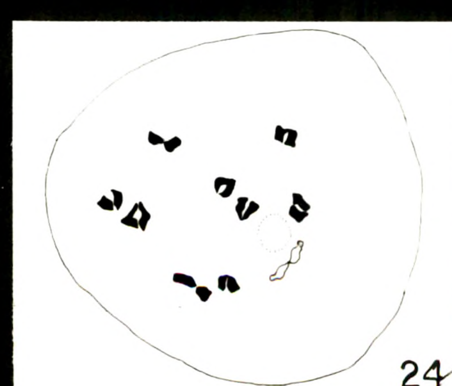


24

PL. 2:5

Pl. 2:6

Nicandra physalodes

Coll. No. 21 (Contd.):

(Meiosis)

Fig. 25 - PMC showing diakinesis. Note 9 normal bivalents and one knobbed isochromosome bivalent near the nucleolus.

Fig. 26 - " " equal distribution of chromosomes at metaphase II (Polar view).

Fig. 27 - " " non synchronised movement and abnormal orientation at anaphase II.

Fig. 28 - " " telophase II (normal).

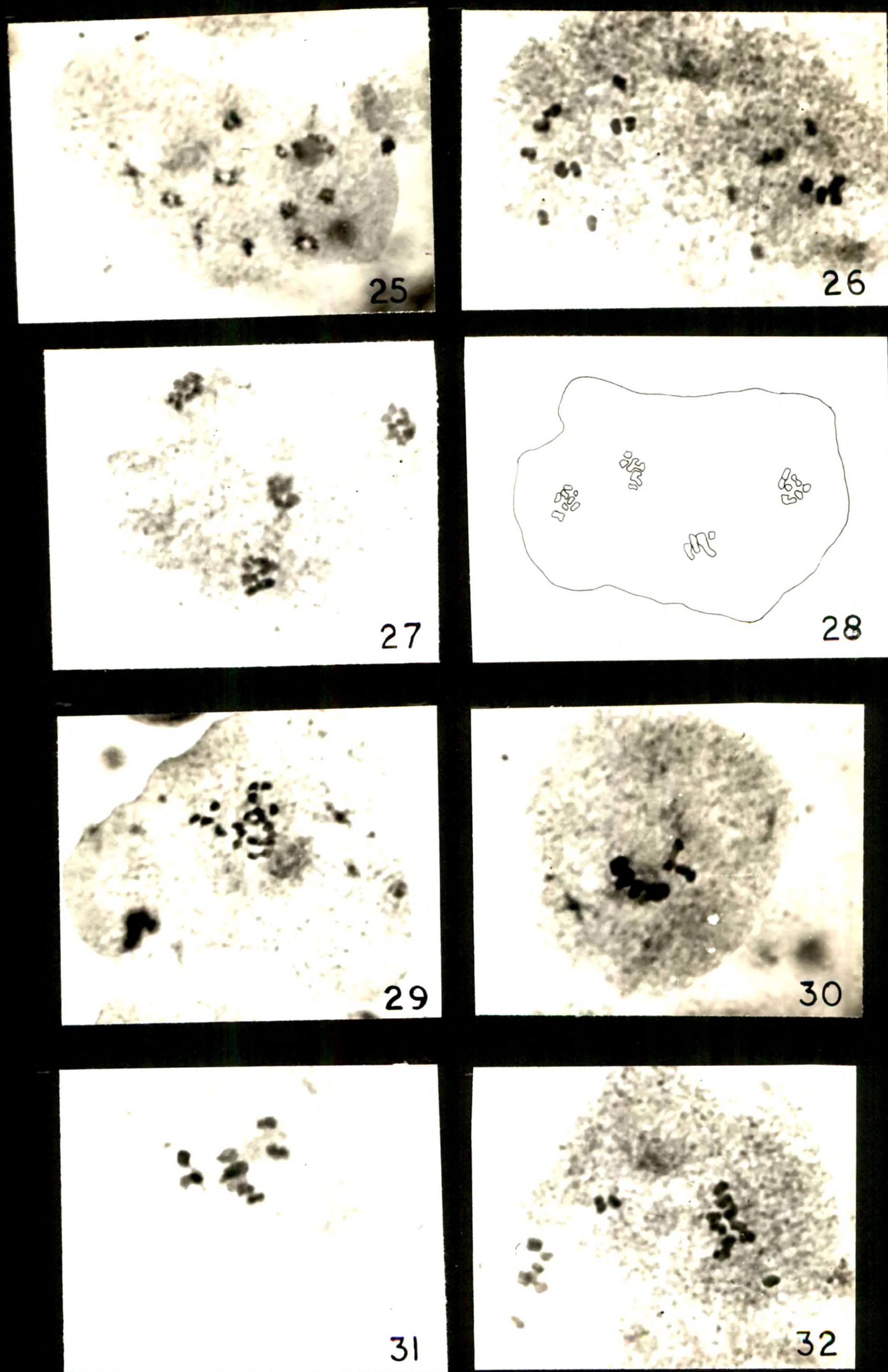
Fig. 29 - " " non synchronised movements of bivalents.

Fig. 30 - " " association of bivalents at metaphase I.

Fig. 31 - " " non synchronised movement of a few bivalents at metaphase I.

Fig. 32 - " " non congressional bivalents (laggards) at metaphase II.

Contd...



PL. 2:6

and abnormal orientation of chromosomes at anaphase II (Fig. 27) are the few abnormalities observed in few PMC's. On the whole meiosis is comparatively more regular (Figs. 22, 28) than the preceding population.

Lycium barbarum L.

Chromosome numbers for some species of Lycium are known. Chromosome number reports for 2 Indian species, are $2n = 24$ for L. europaeum by Malik (1960) and $n = 12$ & 18 for L. barbarum by Baquar, Akhtar & Hussain (1965, 1966). In the present study of L. barbarum $2n = 24$ and $n = 12$ are encountered.

Coll. No. 15 :

Karyotype formula : $A_8+B_4+C_2^S+C_2+F_8$

(Table 2:5)

The noteworthy feature of this taxon is that its somatic complement has more number of longer chromosomes than those of other species analysed in the present study. A pair of chromosome with 4.689 μ length present in the complement, is the longest among the species of Solanaceae studied. Chromosome length within the complement varies between 2.656 to 4.689 μ with a mean length of 1.79 μ. The karyotype is comprised of 10 pairs of chromosomes with nearly submedian centromeres (A, C & F-types) and 2 pairs with nearly median centromeres (B-type). Among the

Table 2:5. Details of the karyotype analysis of <u>Lycium barbarum</u> L. (Coll. No. 15).

Chromosome pair	Long Arm	+	Short Arm	=	Total length (Length in μ)	Arm Ratios R_1	Arm Ratios R_2	Relative length	Centromere	Type
1, 2	3.258	+	1.431	=	4.689	0.43	2.28	100	nsm	A
3, 4	3.009	+	1.369	=	4.378	0.45	2.19	93	nsm	A
5, 6	3.112	+	1.162	=	4.274	0.37	2.67	91	nsm	A
7, 8	2.926	+	1.203	=	4.129	0.41	2.43	88	nsm	A
9,10	2.884	+	0.851	=	3.735	0.29	3.38	79	nsm	C
11,12	2.199	+	1.390	=	3.589	0.63	1.58	76	nm	B
13,14	2.366	+	1.203	=	3.569	0.50	1.96	76	nsm	C^S
15,16	2.117	+	1.452	=	3.569	0.68	2.00	76	nm	B
17,18	2.034	+	0.954	=	2.988	0.46	2.13	63	nsm	F
19,20	2.075	+	0.892	=	2.967	0.42	2.32	63	nsm	F
21,22	1.743	+	0.913	=	2.656	0.52	1.91	56	nsm	F
23,24	1.763	+	0.893	=	2.656	0.50	1.98	56	nsm	F
	29.477		13.713		43.190					

L/S = 1.75

Mean length = 1.79 μ

T F % = 31.75%

Karyotype formula = $2n = 24 = A_8 + B_4 + C_2^S + C_2 + F_8$

chromosomes with nearly submedian centromeres, one pair (C^S-type) is with satellites (Figs. 34, 36). TF%, 31.75% and the idiogram (Fig. 35) reveal the asymmetry of the karyotype. However, presence of longer chromosomes and lesser value of L/S ratio (1.76) are indicative of comparatively primitive nature of the karyotype.

The haploid number n = 12 is ascertained by the observation of 12 distinct bivalents at diakinesis (Fig. 37). In few PMCs, however various groupings of bivalents are also observed (Figs. 38, 39, 40). Occasionally a few non congressional bivalents at telophase I (Figs. 41, 42) and telophase II (Fig. 43) are noticed near both the poles. The determined pollen fertility for the taxon is 96.48%.

<u>Withania</u> <u>somnifera</u> (L.) Dunal

The chromosome number for the haploid set of the taxon was determined as n = 24 by Bhaduri (1933). Thereafter MohanRam & Kamini (1964) confirmed the same through embryological studies. Miege (1960) has reported 2n = 48 for the species. In the present study, n = 24 and 2n = 48 are encountered.

<u>Coll. Nos. 14, 60</u> :

Karyotype formula : $2n = 48 = B_2+C_4+D_8+F_2^S+F_{22}+H_2^S+H_8$

(Table 2:6)

The complement has long, medium as well as short sized

Pl. 2:7

Nicandra physalodes

Coll. No. 21 (Contd.) :

Fig. 33 - PMC showing 5 groups at telophase II.

Lycium barbarum

Coll. No. 15 :

Fig. 34 - Camera lucida drawing of somatic metaphase plate.

Fig. 35 - Idiogram.

Fig. 36 - Photomicrograph of somatic metaphase plate.

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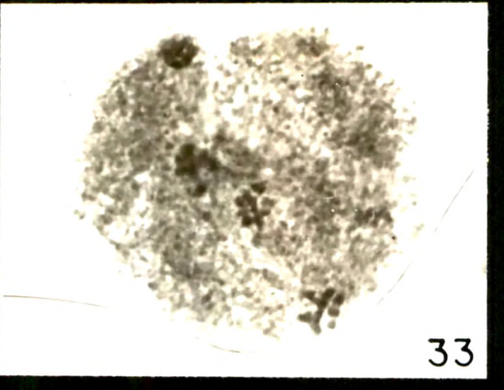
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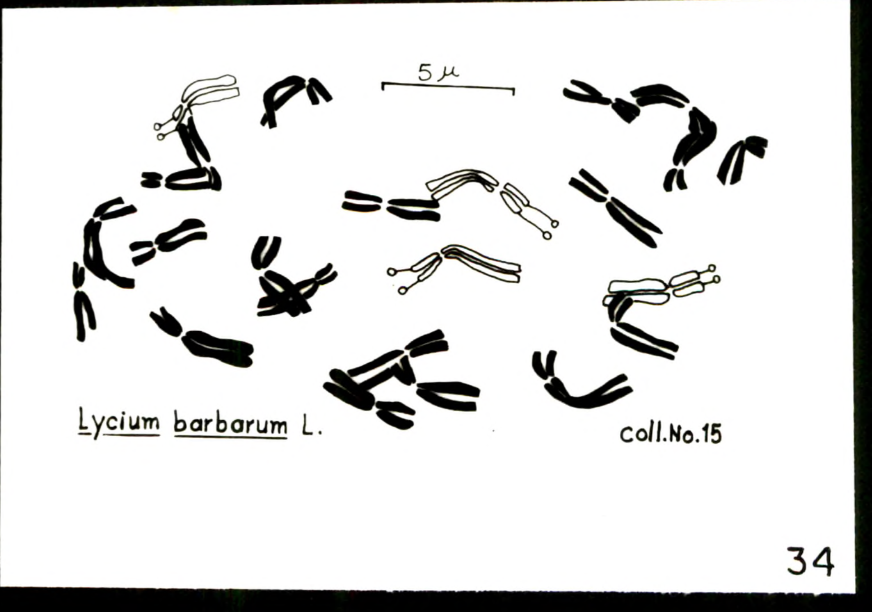
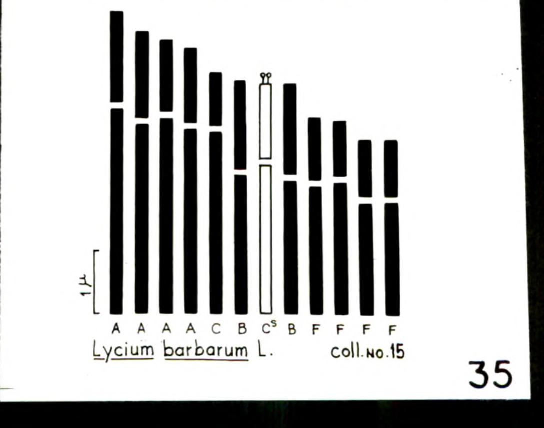

5 μ
Lycium barbarum L.
coll.No.15
34


1 μ
A A A A C B C^s B F F F F
Lycium barbarum L.
coll.No.15
35


36

PL. 2:7

Pl. 2:8

Lycium barbarum

Coll. No. 15 (Contd.) :

(Meiosis)

Fig. 37 - PMC showing 12 distinct bivalents at diakinesis.

Fig. 38 - " " groupings of bivalents $(3_{(III)} + 1_{(II)} + 4_{(I)})$

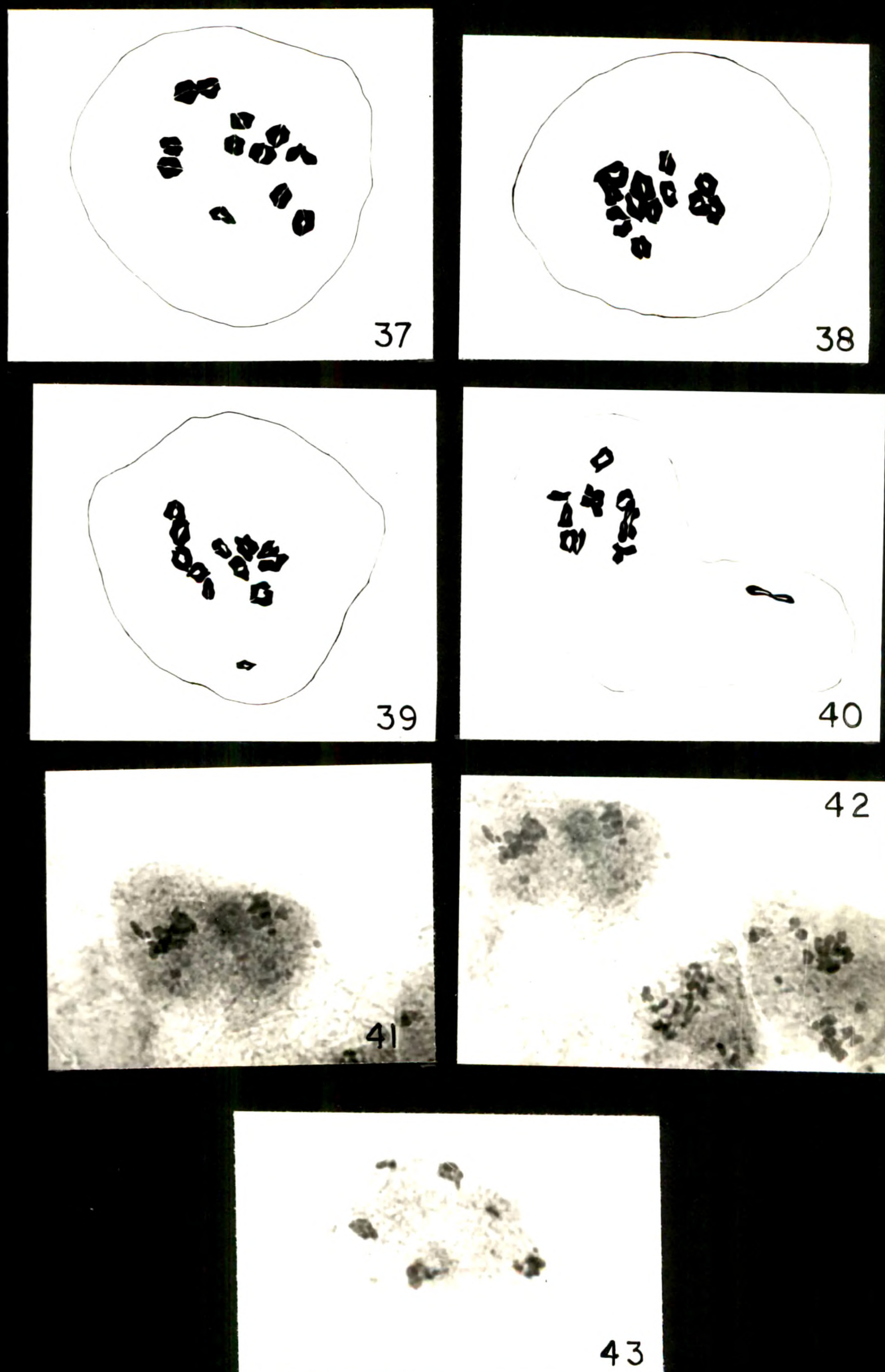
Fig. 39 - " " groupings of bivalents $(1_{(V)} + 1_{(III)} + 4_{(I)})$

Fig. 40 - " " groupings of bivalents $(1_{(IV)} + 3_{(II)} + 2_{(I)})$

Fig. 41 - " " non congressional bivalents at metaphase II.

Fig. 42 - " " non congressional bivalents at metaphase I.

Fig. 43 - " " non congressional bivalents (laggards) at telophase II.



PL. 2:8

Table 2:6. Details of the karyotype analysis of *Withania somnifera* Dun. (Coll. No. 14).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.855	+	1.341	=	3.196	0.72	1.38	100	nm	B
3, 4	2.170	+	0.947	=	3.117	0.43	2.29	97	nsm	C
5, 6	1.973	+	1.065	=	3.038	0.53	1.85	95	nsm	C
7, 8	2.012	+	0.987	=	2.999	0.49	2.03	93	nsm	F
9,10	1.775	+	1.105	=	2.880	0.62	1.60	90	nm	D
11,12	2.052	+	0.789	=	2.841	0.38	2.6	88	nsm	F
13,14	1.933	+	0.868	=	2.801	0.44	2.2	87	nsm	F
15,16	1.775	+	0.987	=	2.762	0.55	1.79	86	nsm	F
17,18	1.815	+	0.947	=	2.762	0.52	1.91	86	nsm	F
19,20	1.775	+	0.947	=	2.722	0.53	1.87	85	nsm	F^S
21,22	1.578	+	1.105	=	2.683	0.70	1.42	83	nm	D
23,24	1.894	+	0.749	=	2.643	0.39	1.71	82	nsm	F
25,26	1.578	+	0.908	=	2.486	0.57	1.73	77	nsm	F
27,28	1.578	+	0.829	=	2.407	0.52	1.90	75	nsm	F
29,30	1.539	+	0.868	=	2.407	0.56	1.77	75	nsm	F
31,32	1.618	+	0.671	=	2.289	0.41	2.41	71	nsm	F
33,34	1.302	+	0.987	=	2.289	0.75	1.31	71	nm	D
35,36	1.499	+	0.750	=	2.249	0.50	1.99	70	nsm	F
37,38	1.263	+	0.789	=	2.052	0.62	1.60	64	nm	D
39,40	1.381	+	0.592	=	1.973	0.42	2.33	61	nsm	H
41,42	1.302	+	0.592	=	1.894	0.45	2.19	59	nsm	H^S
43,44	1.183	+	0.671	=	1.854	0.56	1.76	58	nsm	H
45,46	1.262	+	0.513	=	1.775	0.40	2.46	55	nsm	H
47,48	1.065	+	0.592	=	1.657	0.55	1.79	51	nsm	H
	39.177	+	20.599	=	59.776					

L/S = 1.92

Mean length = 1.25 μ

T F % = 34.46 %

Karyotype formula = 2n = 48 = $B_2 + C_4 + D_8 + F^S_2 + F_{22} + H^S_2 + H_8$

chromosomes, which vary in length from 1.657 to 3.196 μ. The chromosomes are represented by 5 pairs having nearly median (B & D-types) and 19 pairs with nearly submedian (C,F & H-types) centromeres. Within the complement there are 2 pairs of satellited chromosomes (F^S & H^S-types). Calculated values of L/S ratio, mean length and TF% are 1.92, 1.25 μ and 34.36% respectively. The total chromatin length of the complement is 59.776 u, which is comparatively high. Values of relative length for chromosome pairs and idiogram depict the asymmetrical and smoothly graded nature of the karyotype (Figs. 44,45,46).

Regular meiotic behaviour is noticed in majority of the PMCs of both analysed populations. At diakinesis 24 bivalents are distinctly observed (Figs. 47, 48). In few pollen mother cells, however, non congressional bivalents (Figs. 51, 52), bridge formation at telophase II (Fig. 53) and close grouping of some of the bivalents at metaphase I (Fig. 50) are noticed. The determined pollen fertility for the species is 95.24%.

Physalis longifolia Nutt.

Cytological studies of some species of *Physalis* are known to exist in the available literature. But surprisingly *P. longifolia* is not included in the past works. Both n = 24 and 2n = 48 determined for *P. longifolia*, in the present study, confirm the earlier chromosome reports for other species of the genus.

Pl. 2:9

Withania somnifera

Coll. No. 14 :

(Mitosis)

Fig. 44 - Camera lucida drawing of somatic metaphase.

Fig. 45 - Idiogram.

Fig. 46 - Photomicrograph of somatic metaphase.

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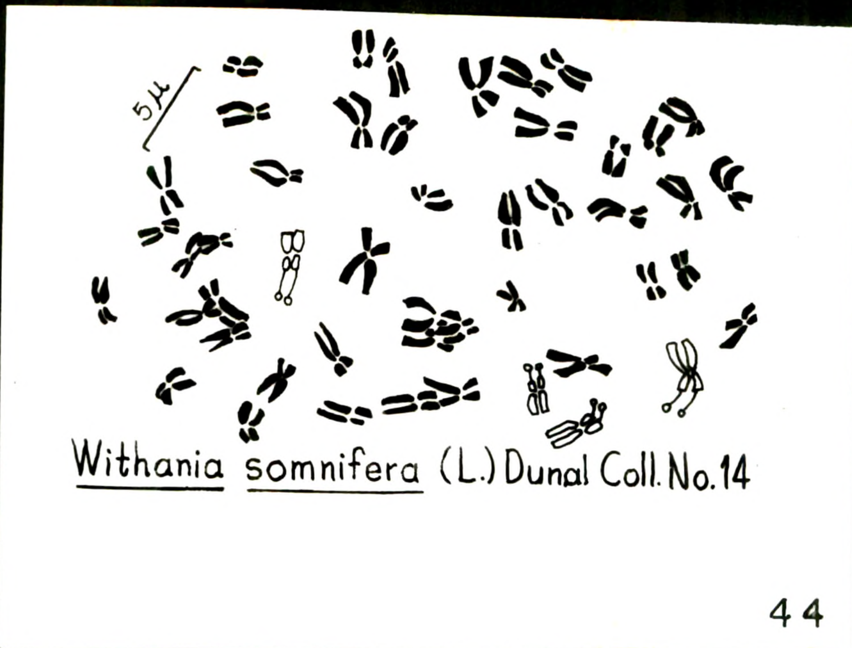
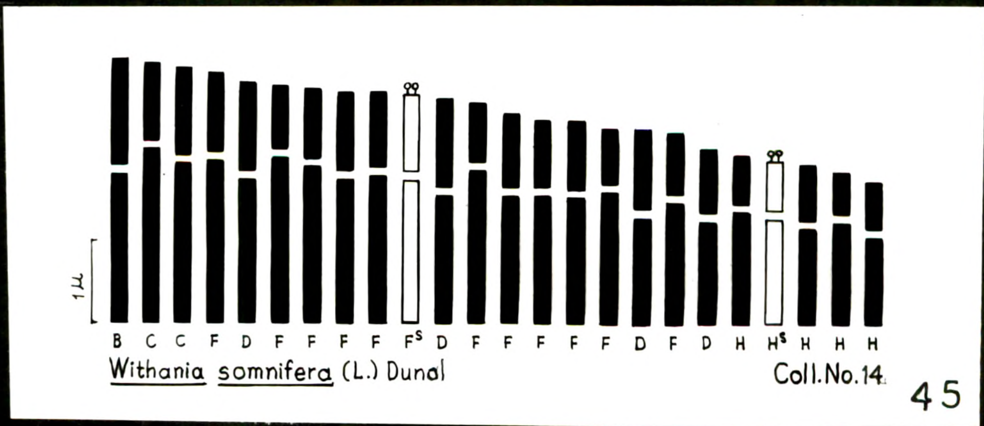
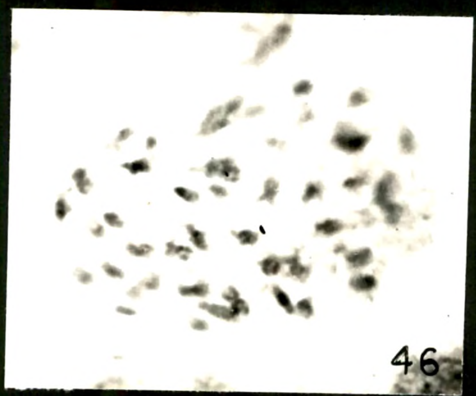

5μ
Withania somnifera (L.) Dunal Coll. No. 14
44


1μ
B C C F D F F F F F^S D F F F F F D F D H H^S H H H
Withania somnifera (L.) Dunal
Coll. No. 14
45


46

PL. 2:9

Pl. 2:10

Withania somnifera

Coll. No. 14 :

(Meiosis)

Fig. 47 - PMC showing 24 bivalents at diakinesis.

Fig. 49 - " " non congressional bivalent at metaphase I.

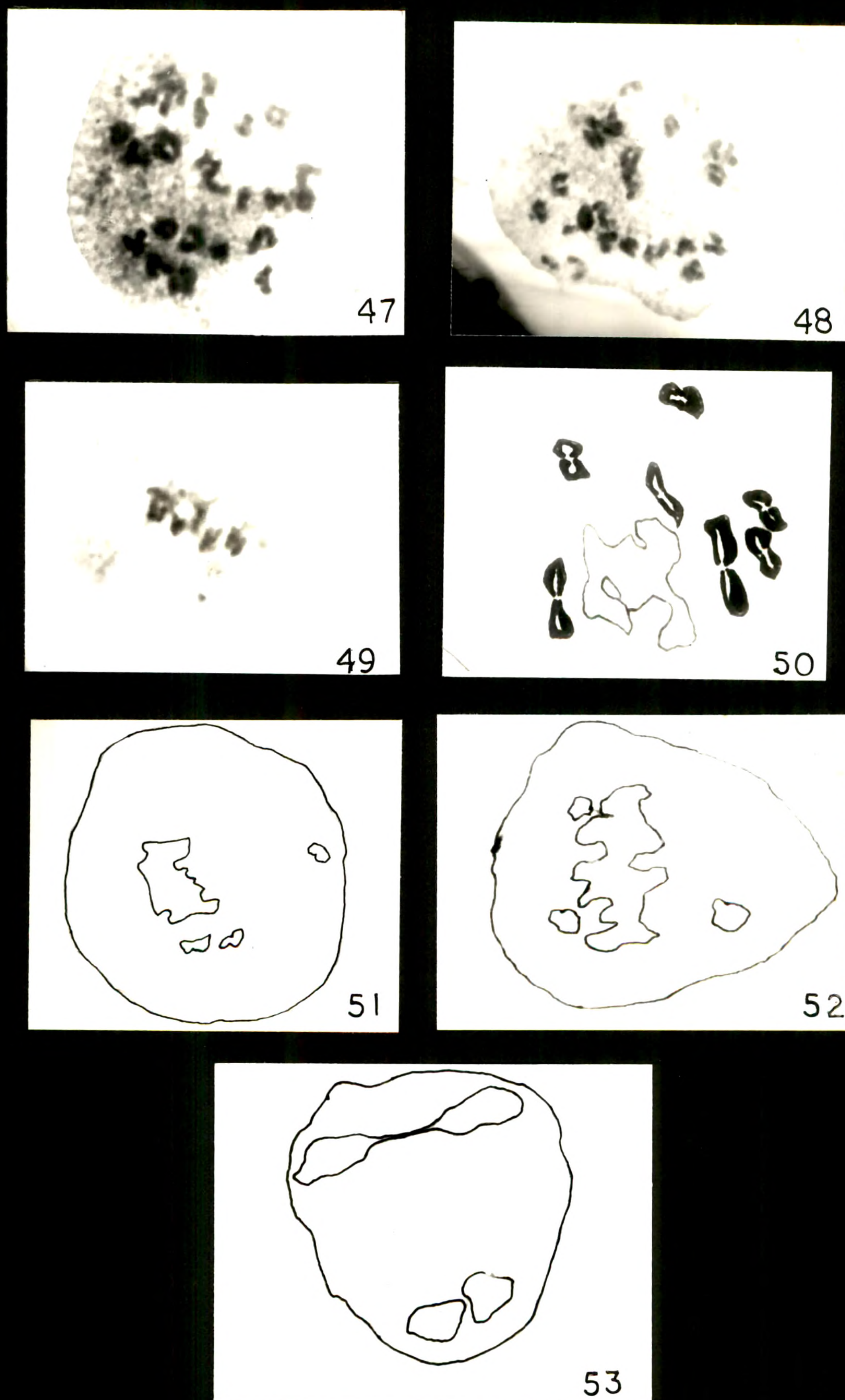
Fig. 50 - " " close grouping of 17 bivalents and 7 distinct bivalents at metaphase I.

Coll. No. 60 :

Fig. 48 - " " 24 bivalents and a nucleolus at diakinesis.

Figs. 51 and 52 - PMCs " non congressional bivalents at metaphase I.

Fig. 53 - PMC " bridge formation at telophase II.



PL. 2:10

<u>Coll. Nos. 38, 39, 41, 43</u> :

Karyotype formulae :

(Coll.Nos. 38 & 41) $2n = 48 = D_2+F_{10}+G^S_2+G_8+H^S_8+H_{18}$

(Table 2:7)

(Coll.Nos. 39 & 43) $2n = 48 = F_8+G^S_4+G_{10}+H^S_4+H_{22}$

(Table 2:8)

The chromosome complements of both the populations have $2n = 48$. However, collection No. 41 is characterised in having 6 pairs of chromosomes with nearly median (D & G-types) and 18 pairs of chromosomes with nearly submedian (F & H-types) centromeres, while collection number 43 is having 7 pairs of chromosomes with nearly median (G-type) and 17 pairs with nearly submedian centromeres (F & H-types), in their somatic complements. Both the collections share the common feature of having 4 pairs of satellited chromosomes (G^S & H^S-types). Moreover, these two populations are having more or less identical values of absolute length, mean length and L/S ratio (Tables 2:7, 2:8 and Figs. 54, 55, 56, 57, 58 and 59).

<u>Coll. No. 45</u> :

Karyotype formula : $2n = 48 = D^{S'}_2+D_{10}+F^{S'}_2+F^S_4+F_{10}+G^S_2+G_6+H^S_2+H_{10}$

(Table 2:9)

Karyotypic analysis of the population revealed the presence

Pl. 2:11

Physalis longifolia

Coll. No. 41 :

(Mitosis)

Fig. 54 - Camera lucida drawing of somatic metaphase plate.

Fig. 55 - Idiogram.

Fig. 56 - Photomicrograph of somatic metaphase plate.

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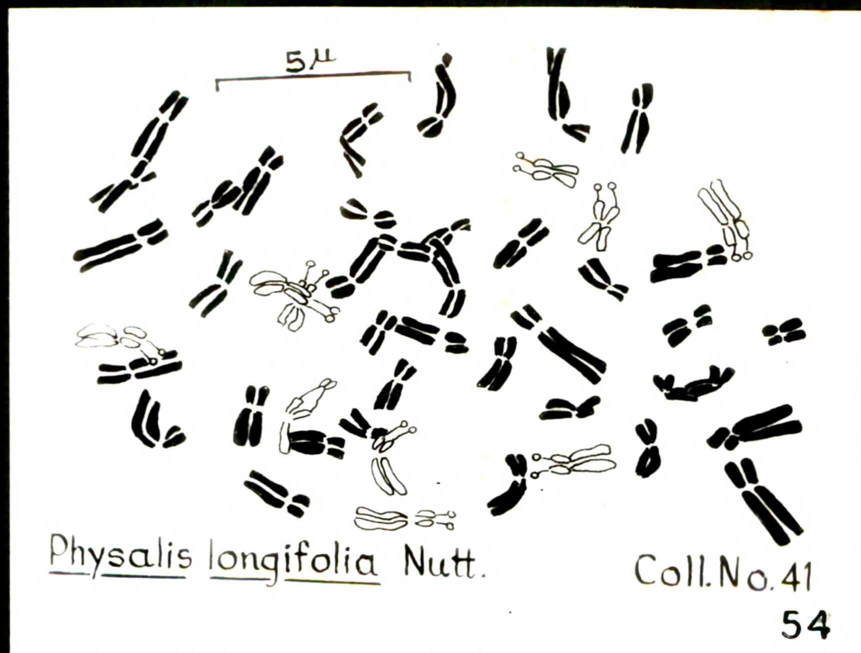
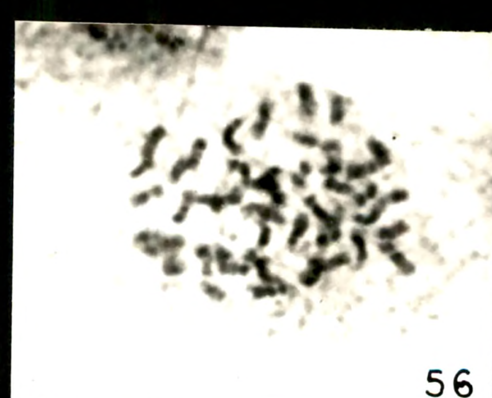


Physalis longifolia Nutt. Coll. No. 41

54

Physalis longifolia Nutt. Coll. No. 41

55



56

PL. 2:11

Pl. 2:12

Physalis longifolia

Coll. No. 43 :

(Mitosis)

Fig. 57 - Camera lucida drawing of somatic metaphase plate.

Fig. 58 - Idiogram.

Fig. 59 - Photomicrograph of somatic metaphase plate.

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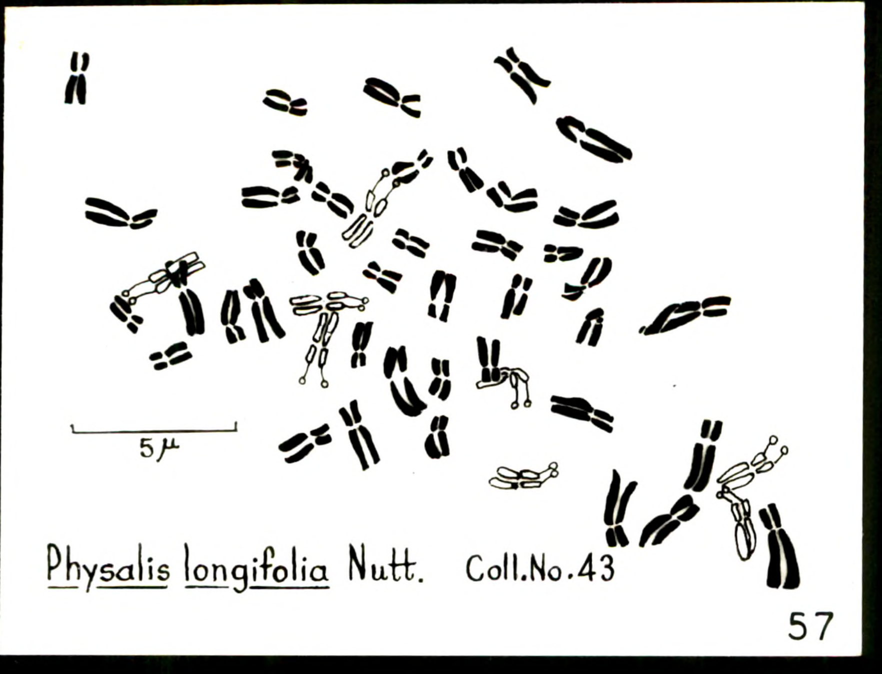
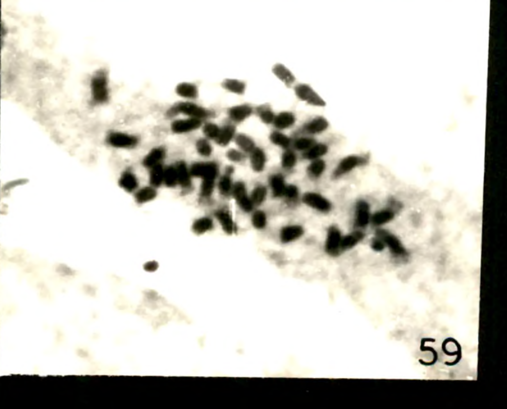

5μ
Physalis longifolia Nutt. Coll.No.43
57


1μ
F F F F H H H G H G^S H^S H^S H G G G^S H H H G H G H H
Physalis longifolia Nutt. Coll. No. 43
58


59

PL. 2:12

Table 2:7. Details of the karyotype analysis of <u>Physalis longifolia</u> Nutt. (Coll. No. 41).

Chromosome pair	Length in μ: Long Arm	+	Short Arm	=	Total Length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.992	+	0.705	=	2.697	0.35	2.82	100	nsm	F
3, 4	1.722	+	0.685	=	2.407	0.39	2.51	89	nsm	F
5, 6	1.784	+	0.540	=	2.324	0.30	3.30	86	nsm	F
7, 8	1.681	+	0.622	=	2.303	0.37	2.70	85	nsm	F
9,10	1.307	+	0.809	=	2.116	0.61	1.61	78	nm	D
11,12	1.432	+	0.664	=	2.096	0.46	2.15	77	nsm	F
13,14	1.390	+	0.539	=	1.929	0.38	2.57	71	nsm	H
15,16	1.286	+	0.622	=	1.908	0.48	2.06	70	nsm	H
17,18	1.286	+	0.581	=	1.867	0.45	2.21	69	nsm	H
19,20	1.328	+	0.436	=	1.764	0.32	3.04	65	nsm	H
21,22	0.975	+	0.726	=	1.701	0.74	1.34	63	nm	G
23,24	1.100	+	0.560	=	1.660	0.50	1.96	61	nsm	H^S
25,26	1.120	+	0.457	=	1.577	0.40	2.45	58	nsm	H^S
27,28	1.079	+	0.457	=	1.536	0.42	2.36	57	nsm	H
29,30	0.892	+	0.581	=	1.473	0.65	1.53	54	nm	G
31,32	0.830	+	0.622	=	1.452	0.74	1.33	53	nm	G
33,34	0.975	+	0.436	=	1.411	0.44	2.23	52	nsm	H
35,36	0.871	+	0.519	=	1.390	0.59	1.67	51	nsm	H^S
37,38	0.892	+	0.477	=	1.369	0.53	1.87	50	nsm	H
39,40	0.830	+	0.436	=	1.266	0.52	1.90	46	nsm	H^S
41,42	0.747	+	0.436	=	1.183	0.58	1.71	43	nsm	H
43,44	0.685	+	0.456	=	1.141	0.66	1.50	42	nm	G^S
45,46	0.705	+	0.436	=	1.141	0.61	1.61	42	nm	G
47,48	0.643	+	0.353	=	0.996	0.54	1.82	36	nsm	H
	27.552		13.155		40.707					

L/S = 2.70

Mean length = 0.85 μ

T F % = 32.31%

Karyotype formula = $2n = 48 = D_2 + F_{10} + G_2^S + G_8 + H_8^S + H_{18}$

Table 2:8. Details of the karyotype analysis of <u>Physalis longifolia</u> Nutt. (Coll. No. 43).

Chromosome Pair	Length in μ Long Arm	+	Short Arm	=	Total Length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.909	+	0.996	=	2.905	0.52	1.91	100	nsm	F
3, 4	1.598	+	0.954	=	2.552	0.59	1.67	87	nsm	F
5, 6	1.577	+	0.809	=	2.386	0.51	1.94	82	nsm	F
7, 8	1.618	+	0.685	=	2.303	0.42	2.36	79	nsm	F
9,10	1.266	+	0.726	=	1.992	0.57	1.74	68	nsm	H
11,12	1.224	+	0.643	=	1.867	0.52	1.90	64	nsm	H
13,14	1.245	+	0.602	=	1.847	0.48	2.06	63	nsm	H
15,16	1.120	+	0.705	=	1.825	0.62	1.58	62	nm	G
17,18	1.183	+	0.581	=	1.764	0.49	2.03	60	nsm	H
19,20	1.079	+	0.664	=	1.743	0.61	1.62	60	nm	G^S
21,22	1.079	+	0.643	=	1.722	0.59	1.67	59	nsm	H^S
23,24	1.079	+	0.519	=	1.598	0.48	2.07	55	nsm	H^S
25,26	1.037	+	0.519	=	1.556	0.50	1.99	53	nsm	H
27,28	0.934	+	0.601	=	1.535	0.64	1.55	52	nm	G
29,30	0.913	+	0.581	=	1.494	0.63	1.57	51	nm	G
31,32	0.892	+	0.581	=	1.473	0.65	1.53	50	nm	G^S
33,34	0.913	+	0.539	=	1.452	0.59	1.69	49	nsm	H
35,36	0.913	+	0.477	=	1.390	0.52	1.91	47	nsm	H
37,38	0.892	+	0.477	=	1.369	0.53	1.87	47	nsm	H
39,40	0.768	+	0.519	=	1.287	0.67	1.47	44	nm	G
41,42	0.913	+	0.311	=	1.224	0.34	2.93	42	nsm	H
43,44	0.705	+	0.498	=	1.203	0.70	1.21	41	nm	G
45,46	0.747	+	0.394	=	1.141	0.52	1.89	39	nsm	H
47,48	0.684	+	0.415	=	1.099	0.60	1.64	37	nsm	H
	26.288		14.439		40.727					

L/S = 2.64

Mean length = 0.85 μ

T F % = 35.45 %

Karyotype formula = $2n = 48 = F_8 + G_4^S + G_{10} + H_4^S + H_{22}$

Table 2:9. Details of the karyotype analysis of <u>Physalis longifolia</u> Nutt. (Coll. No. 45).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.081 + 0.991	+	0.901	=	2.982	0.43	2.30	100	nsm	$F^{S'}$
3, 4	1.982	+	0.946	=	2.928	0.47	2.10	98	nsm	F
5, 6	1.711	+	1.171	=	2.882	0.68	1.46	96	nm	D
7, 8	0.811 + 0.901	+	1.081	=	2.793	0.63	1.58	93	nm	$D^{S'}$
9,10	1.756	+	0.946	=	2.702	0.53	1.86	90	nsm	F^S
11,12	1.531	+	1.125	=	2.656	0.73	1.36	89	nm	D
13,14	1.486	+	1.125	=	2.611	0.75	1.32	87	nm	D
15,16	1.711	+	0.766	=	2.477	0.44	2.23	83	nsm	F
17,18	1.576	+	0.811	=	2.387	0.51	1.94	80	nsm	F^S
19,20	1.531	+	0.811	=	2.342	0.53	1.89	78	nsm	F
21,22	1.486	+	0.766	=	2.252	0.52	1.94	75	nsm	F
23,24	1.441	+	0.766	=	2.207	0.53	1.88	74	nsm	F
25,26	1.180	+	0.991	=	2.171	0.84	1.19	72	nm	D
27,28	1.306	+	0.856	=	2.162	0.65	1.53	72	nm	D
29,30	1.216	+	0.766	=	1.982	0.63	1.59	66	nm	G^S
31,32	1.261	+	0.721	=	1.982	0.57	1.75	66	nsm	H
33,34	1.080	+	0.811	=	1.891	0.75	1.33	63	nm	G
35,36	1.125	+	0.721	=	1.846	0.64	1.56	61	nm	G
37,38	1.261	+	0.585	=	1.846	0.46	2.16	61	nsm	H
39,40	1.261	+	0.540	=	1.801	0.43	2.33	60	nsm	H
41,42	1.125	+	0.631	=	1.756	0.56	1.78	58	nsm	H
43,44	0.991	+	0.585	=	1.576	0.59	1.69	52	nsm	H
45,46	0.901	+	0.631	=	1.543	0.70	1.43	51	nm	G
47,48	0.901	+	0.450	=	1.351	0.50	2.00	45	nsm	H^S
	33.602		19.503		53.105					

L/S = 2.20

Mean length = 1.11 μ

T F % = 36.72%

Karyotype formula = 2n=48 = $D_2^{S'} + D_{10} + F_2^{S'} + F_4^S + F_{10} + G_2^S + G_6 + H_2^S + H_{10}$

Table 2:10. Comparison of the somatic chromosomes of different populations of *Physalis longifolia* Nutt.

Populations	Somatic number (2n)	n m Types		n s m Types		Chromosomes with secondary constrictions		Chromosomes with satellites			Absolute length in μ	Mean length in μ	L/S
		D	G	F	H	$D^{S'}$	$F^{S'}$	F^S	G^S	H^S			
41	48	2	10	10	26	-	-	-	2	8	40.707	0.85	2.70
43	48	-	14	8	26	-	-	-	4	4	40.727	0.85	2.64
45	48	12	8	16	12	2	2	4	2	2	53.105	1.11	2.20

of 14 pairs of chromosomes with nearly submedian (F & H-types) and 10 pairs with nearly median (D & G-types) centromeres. Chromosomes within the complement are medium to short sized, ranging in length from 1.351 to 2.982 μ with a mean length of 1.106 μ. Among 14 pairs with nearly submedian centromeres, 8 pairs belong to F-type and 6 pairs to H-type. While 10 pairs with nearly median centromeres are represented by 6 pairs of D-type and 4 pairs of G-type. Within the complement there are 4 pairs of satellited chromosomes (F^S, G^S & H^S-types) and 2 pairs of secondarily constricted chromosomes ($D^{S'}$ & $F^{S'}$-types) having secondary constrictions on long arms. Higher values of L/S ratio (2.20) and TF% (36.72%) indicate the evolved nature of the karyotype. Comparatively evolved nature of the karyotype and smooth gradation is also evident in the idiogram (Figs.60,61).

Karyotype of Coll. No. 45 distinctly differs from the others in having more pairs (10 pairs) with nearly median and less pairs of chromosomes with nearly submedian centromeres. Two pairs of secondarily constricted chromosomes observed in the same are absent in the other populations studied. The determined values of absolute length, mean length and L/S ratio are comparatively higher (Table 2:10). Karyotypes of all the populations studied are evolved and smoothly graded.

Observed morphological differences in the vegetative characters of these populations, coupled with structural karyotypic differences among them indicate the presence of 2 distinct ecotypes within the species.

Pl. 2:13

Physalis longifolia

Coll. No. 45 :

(Mitosis)

Fig. 60 - Camera lucida drawing of somatic metaphase plate.

Fig. 61 - Idiogram.

Fig. 63.- Metaphase I (side view).

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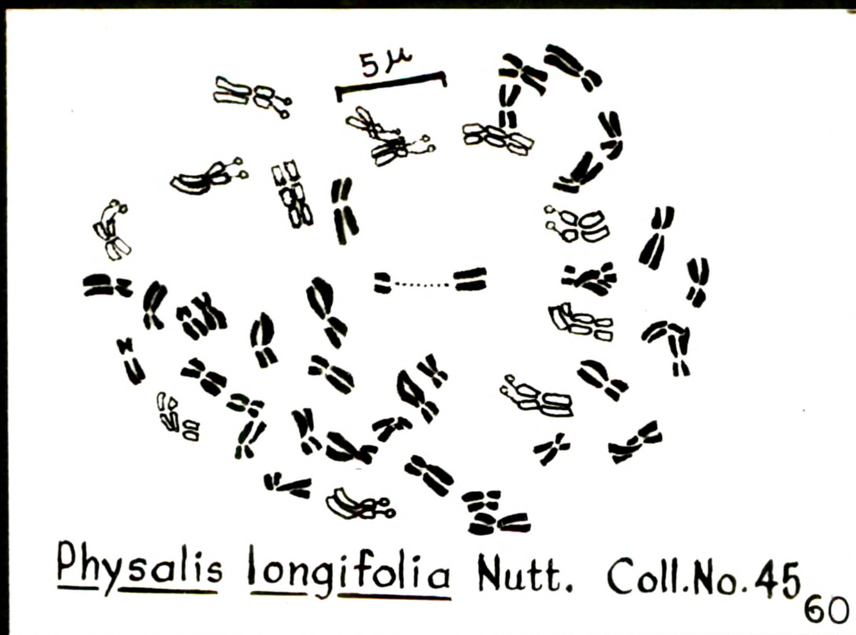
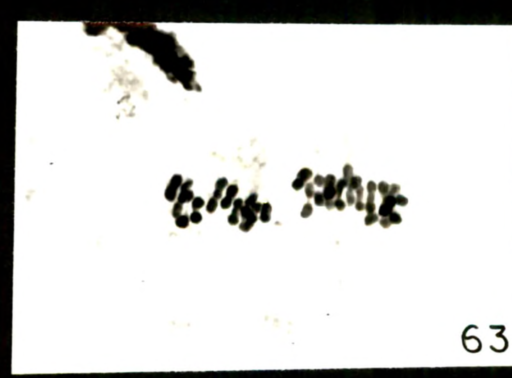


60

61


63

PL. 2:13

The regular meiotic behaviour is evident by the presence of 24 bivalents at diakinesis (Fig. 64) at metaphase I (Figs. 63, 74), anaphase I (Fig. 65, 73), metaphase II (Fig.66) and telophase II (Fig. 67) resulting in the formation of regular tetrads (Figs. 68, 76). Equal distribution at first and second meiotic division is observed in majority of the pollen mother cells. However, in few, variable number of laggards are observed during first meiotic division (Figs. 69, 70) and at telophase II (Fig. 71) are observed. Also in few PMCs, non congressional bivalents at metaphase I are observed. The high percentage of pollen fertility (99.22%) indicates that the above mentioned abnormalities are of rare occurrence.

Physalis minima L.

For the species under consideration, Bhaduri (1933) has reported n = 24. All subsequent researchers viz., Gottschalk (1954), Baquar, Akhtar & Hussain (1965, 1966) have reported 2n = 48. Recently George & Rao (1979) have been successful in producing a triploid form (3n = 72) for the species. In the present study, of the populations of P. minima, earlier reports of 2n = 48, are confirmed.

Coll. No. 37:

Karyotype formula : $2n = 48 = C_2+D_2^S+D_6+E_2+F_2^S+F_{22}+G_4+H_8$

(Table 2:11)

Pl. 2:14

Physalis longifolia

Coll. No. 45 :

(Meiosis)

Fig. 64 -	PMC	showing	24 bivalents at diakinesis.
Fig. 65 -	"	"	equal (24:24) distribution of chromosomes at anaphase I.
Fig. 66 -	"	"	metaphase II (Polar view).
Fig. 67 -	"	"	normal distribution of chromosomes at telophase II.
Fig. 68 -	"	"	isobilateral tetrad formation.
Figs. 69 and 70-	PMCs	"	variable number of laggards during first meiotic division.
Fig. 71 -	PMC	"	laggards at telophase II.

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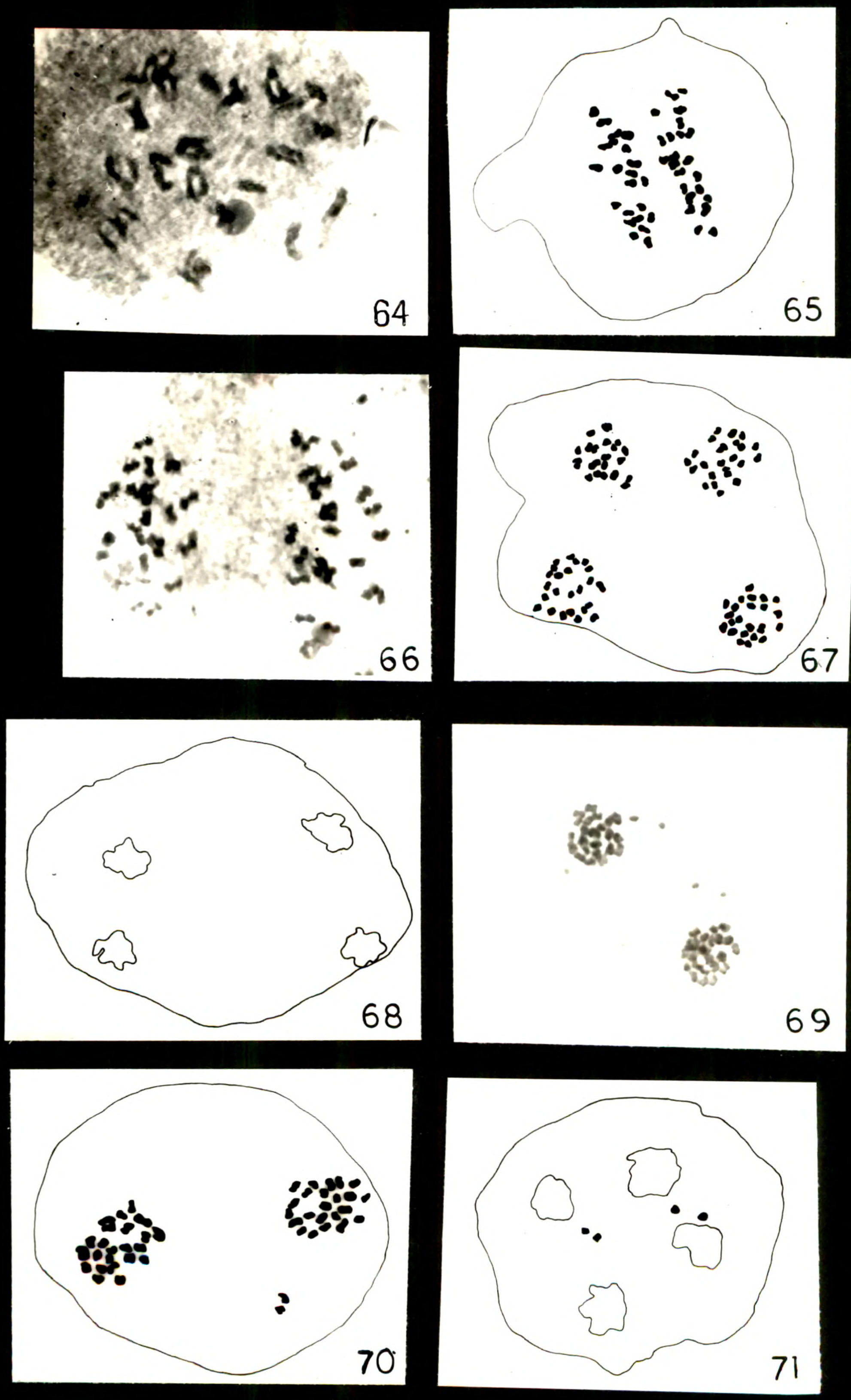


PL. 2:14

Pl. 2:15

Physalis longifolia

Coll. No. 41 :

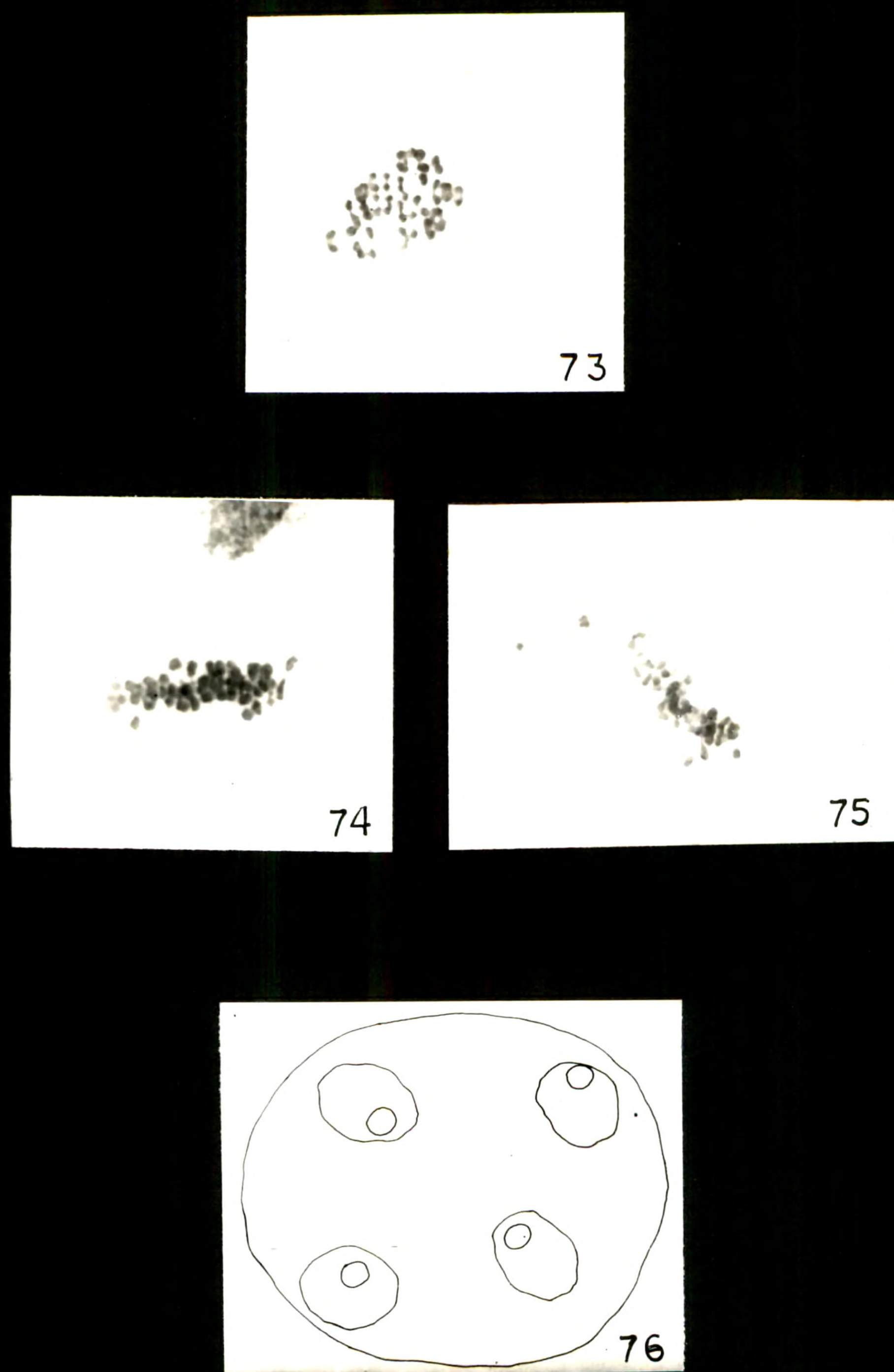
(Meiosis)

Fig. 73 - PMC showing anaphase I (early).

Fig. 74 - " " metaphase I (Side view).

Fig. 75 - " " few non congressional bivalents at metaphase I.

Fig. 76 - " " isobilateral tetrad formation.



PL. 2:15

Table 2:11. Details of the karyotype analysis of <u>Physalis minima</u> L. (Coll. No. 37).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	2.328	+	0.828	=	3.156	0.35	2.80	100	nsm	C
3, 4	2.052	+	0.947	=	2.999	0.46	2.16	94	nsm	F
5, 6	1.973	+	0.947	=	2.920	0.48	2.08	92	nsm	F^S
7, 8	1.776	+	1.105	=	2.881	0.62	1.60	91	nm	D
9,10	2.052	+	0.789	=	2.841	0.38	2.60	89	nsm	F
11,12	1.894	+	0.947	=	2.841	0.50	2.00	89	nsm	F
13,14	1.499	+	1.263	=	2.762	0.84	1.18	87	nm	D
15,16	1.657	+	0.987	=	2.644	0.59	1.68	83	nsm	F
17,18	1.499	+	1.066	=	2.565	0.71	1.40	81	nm	D^S
19,20	1.618	+	0.947	=	2.565	0.58	1.70	81	nsm	F
21,22	1.736	+	0.789	=	2.525	0.45	2.19	79	nsm	F
23,24	1.894	+	0.631	=	2.525	0.33	3.00	78	SM	E
25,26	1.815	+	0.671	=	2.486	0.37	2.70	78	nsm	F
27,28	1.578	+	0.868	=	2.446	0.55	1.81	77	nsm	F
29,30	1.578	+	0.868	=	2.446	0.55	1.81	77	nsm	F
31,32	1.460	+	0.947	=	2.407	0.64	1.54	76	nm	D
33,34	1.578	+	0.789	=	2.367	0.50	1.99	74	nsm	F
35,36	1.381	+	0.789	=	2.170	0.57	1.75	68	nsm	F
37,38	1.420	+	0.513	=	1.933	0.36	2.76	61	nsm	H
39,40	1.144	+	0.671	=	1.815	0.58	1.70	57	nsm	H
41,42	1.263	+	0.552	=	1.815	0.43	2.28	57	nsm	H
43,44	1.223	+	0.552	=	1.775	0.45	2.21	56	nsm	H
45,46	0.947	+	0.789	=	1.736	0.83	1.19	54	nm	G
47,48	0.868	+	0.631	=	1.499	0.72	1.37	47	nm	G
	38.233		19.886		58.119					

L/S = 2.10

Mean length = 1.21 μ

T F %=34.20 %

Karyotype formula = 2n = 48 = $C_2 + D_2^S + D_6 + E_2 + F_2^S + F_{22} + G_4 + H_8$

Like the preceding species, the karyotype revealed the presence of more pairs of chromosomes with nearly submedian centromeres in the somatic complement. Within the complement, there are 17 pairs of chromosomes with nearly submedian (C,F & H-types), 6 pairs with nearly median (D & G-types) and only one pair (E-type) with exactly submedian centromeres. The chromosome length ranges from 1.499 to 3.156 μ with a mean length of 1.21 μ. Total absence of secondarily constricted chromosomes in the somatic complement is worth noting. However, the complement has 2 pairs of satellited chromosomes belonging to D^S and F^S types. The evolved nature of the karyotype is evident in the idiogram and same is proved by the determined value of TF% (34.2%) (Figs. 77, 78, 79).

Coll. No. 42 :

Karyotype formula : $2n = 48 = F_2^{S'}+F_2+H_2^{S'}+H_6^S+H_{16}+G_{20}$

(Table 2:12)

Like previous collection, this population also has only medium and short sized chromosomes in the somatic complement. But number of chromosomes having length less than 2 μ are as many as 44 and remaining 4 are more than 2 μ in length. Among these, there are 10 pairs with nearly median (G-type) and 14 pairs with nearly submedian (F & H-types) centromeres. The chromosome pair with submedian centromere noticed in the karyotype of previous collection, is not noticed in the present

Pl. 2:16

Physalis minima

Coll. No. 37 :

(Mitosis)

Fig. 77 - Camera lucida drawing of somatic metaphase plate.

Fig. 78 - Idiogram.

Fig. 79 - Photomicrograph of somatic metaphase plate.

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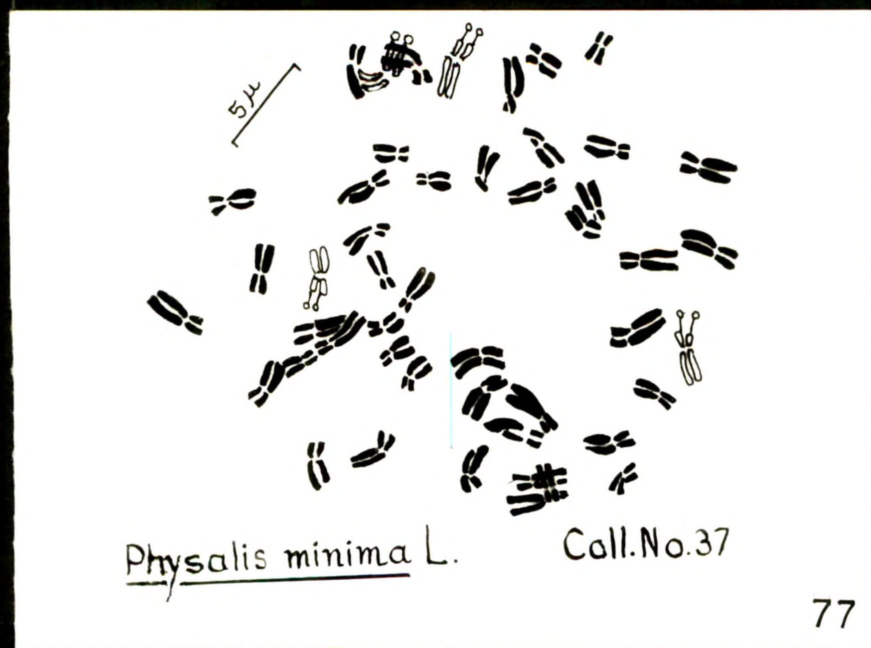
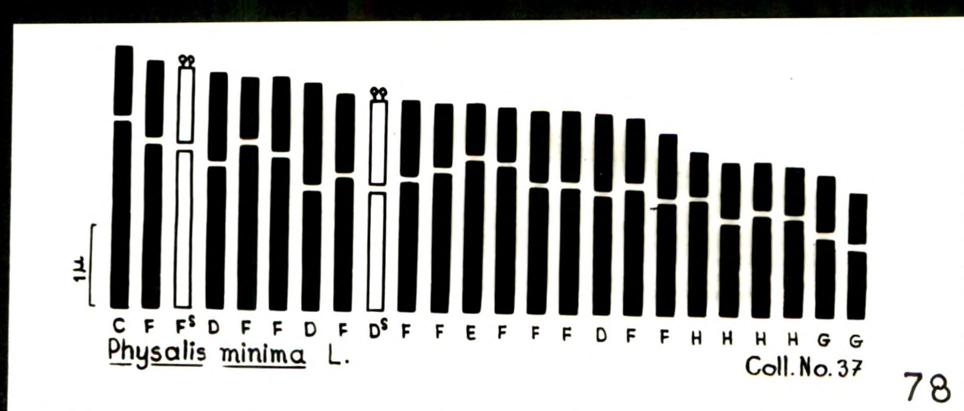
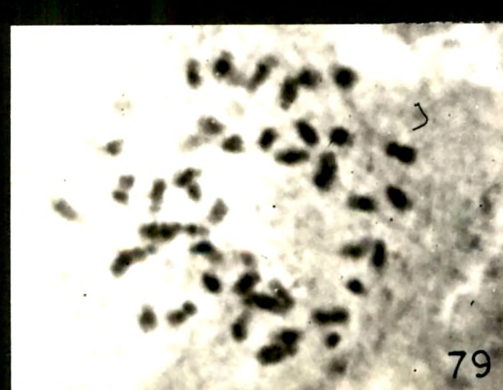

5μ
Physalis minima L.
Coll.No.37
77


1μ
C F F^S D F F D F D^S F F E F F F D F F H H H H G G
Physalis minima L.
Coll.No.37
78


79

PL. 2:16

Table 2:12. Details of the karyotype analysis of <u>Physalis minima</u> L. (Coll. No. 42).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	+0.809 +0.706	+	0.706	=	2.221	0.46	2.14	100	nsm	$F^{S'}$
3, 4	1.453	+	0.706	=	2.159	0.48	2.05	97	nsm	F
5, 6	1.328	+	0.623	=	1.951	0.46	2.13	87	nsm	H
7, 8	+0.706 +0.560	+	0.664	=	1.930	0.52	1.90	86	nsm	$H^{S'}$
9,10	1.245	+	0.685	=	1.930	0.55	1.81	86	nsm	H
11,12	1.141	+	0.768	=	1.909	0.67	1.48	85	nm	G
13,14	1.183	+	0.726	=	1.909	0.61	1.62	85	nm	G
15,16	1.058	+	0.747	=	1.805	0.70	1.41	81	nm	G
17,18	1.183	+	0.602	=	1.785	0.50	1.96	80	nsm	H
19,20	1.141	+	0.602	=	1.743	0.52	1.89	78	nsm	H
21,22	1.100	+	0.623	=	1.723	0.56	1.76	77	nsm	H^S
23,24	1.058	+	0.665	=	1.723	0.62	1.59	77	nm	G
25,26	1.204	+	0.498	=	1.702	0.41	2.41	76	nsm	H
27,28	0.955	+	0.747	=	1.702	0.78	1.27	76	nm	G
29,30	1.058	+	0.602	=	1.660	0.56	1.75	74	nsm	H
31,32	1.079	+	0.498	=	1.577	0.46	2.16	71	nsm	H^S
33,34	0.913	+	0.643	=	1.556	0.70	1.42	70	nm	G
35,36	0.913	+	0.643	=	1.556	0.70	1.42	70	nm	G
37,38	1.017	+	0.519	=	1.536	0.51	2.13	69	nsm	H
39,40	0.851	+	0.498	=	1.349	0.58	1.70	60	nsm	H
41,42	0.809	+	0.498	=	1.307	0.61	1.62	58	nm	G
43,44	0.768	+	0.374	=	1.142	0.48	2.05	51	nsm	H^S
45,46	0.602	+	0.457	=	1.059	0.76	1.31	47	nm	G
47,48	0.581	+	0.436	=	1.017	0.75	1.18	45	nm	G
	25.421		14.530		39.951					

L/S = 2.18
Mean length = 0.83 μ
T F % = 36.36%
Karyotype formula = $2n = 48 = F_2^{S'} + F_2 + H_2^{S'} + H_6^S + H_{16} + G_{20}$

one. The chromosome length varies between 1.017 to 2.221 μ with a mean length of 0.83 μ. The complement of the present population has 2 pairs of secondarily constricted chromosomes ($F^{S'}$ & $H^{S'}$-types) and 3 pairs of satellited chromosomes (H^{S}-type). The TF% and L/S ratio values do not differ much in the studied populations (Table 2:13) (Fig. 80, 81, 82).

Differences in morphological features of the plants of 2 populations are noticed. The scrutiny of the karyotypes of these populations also revealed differences in the number of different types of chromosomes and the number of chromosomes having secondary constrictions or satellites. Marked difference in the absolute length of 2 populations is worth noting.

The present study, therefore, indicates the presence of 2 ecotypes within the circumscription of a species.

Meiotic behaviour in general is regular. 24 distinct bivalents are observed both at diakinesis (Fig. 83) and metaphase I (Fig. 84). However, groupings of bivalents at late diakinesis (Fig. 86), early separation of few bivalents at metaphase I (Fig. 85) and duplicating chromosomes at metaphase II along with few non synchronised ones (Fig. 87) are observed. The determined pollen fertility for the species is 95.25%.

<u>Solanum</u> L.

<u>Solanum</u> <u>villosum</u> subsp. <u>villosum</u>

The chromosome number of the somatic complement (2n = 48)

Pl. 2:17

Physalis minima

Coll. No. 42 :

(Mitosis)

Fig. 80 - Camera lucida drawing of somatic metaphase plate.

Fig. 81 - Idiogram.

Fig. 82 - Photomicrograph of somatic metaphase plate.

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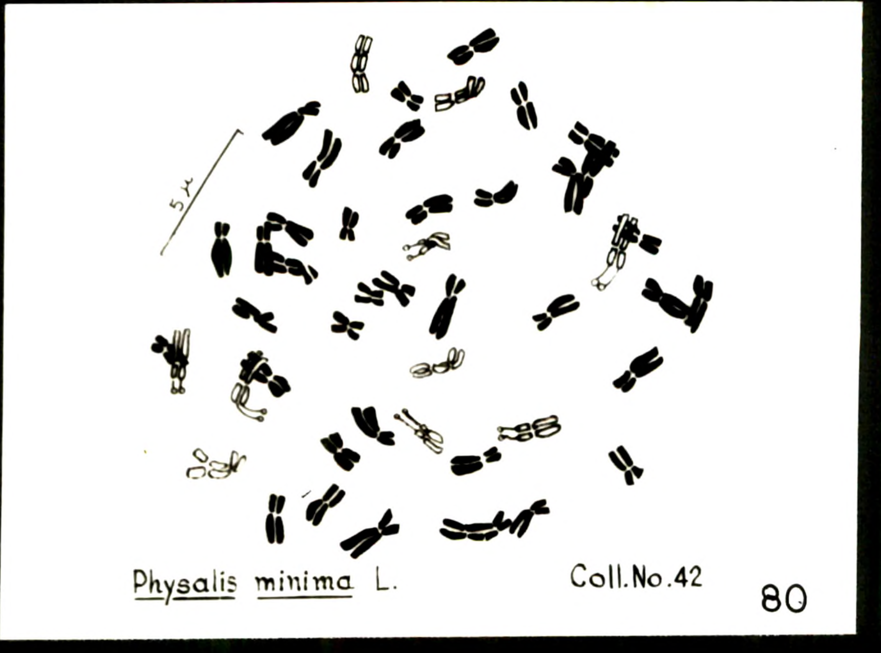
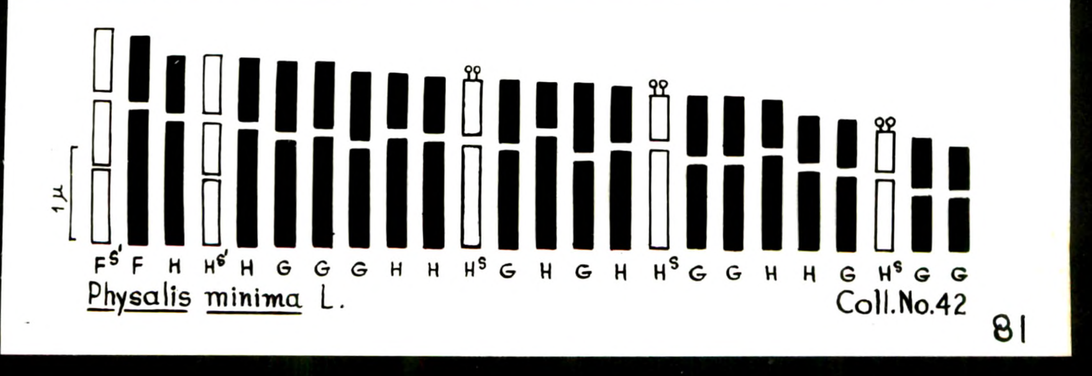
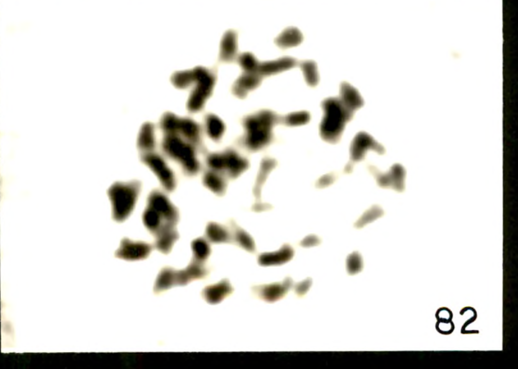

5 μ
Physalis minima L.
Coll.No.42
80


1 μ
F^S' F H H^S' H G G G H H H^S G H G H H^S G G H H G H^S G G
Physalis minima L.
Coll.No.42
81


82

PL. 2: 17

Pl. 2:18

Physalis minima

Coll. No. 37 :

(Meiosis)

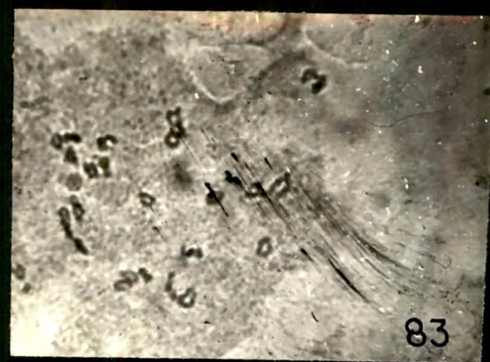
Fig. 83 - PMC showing 24 bivalents at diakinesis.

Fig. 84 - " " " bivalents at metaphase I (side view).

Fig. 85 - " " early separation of few bivalents at metaphase I.

Fig. 86 - " " groupings of bivalents at late diakinesis.

Fig. 87 - " " duplicating chromosomes at metaphase II along with few non synchronised ones in the middle.



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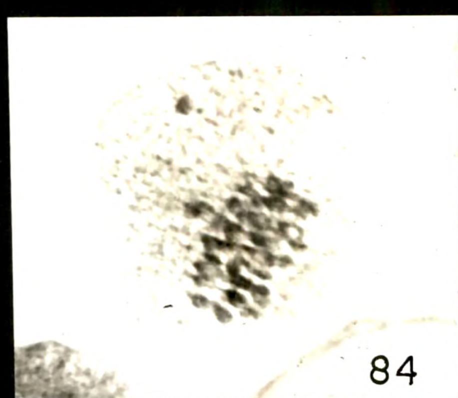

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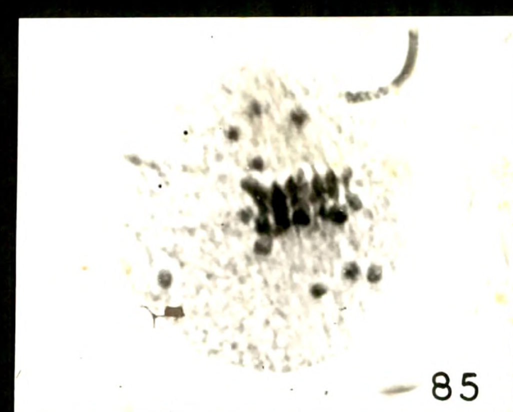

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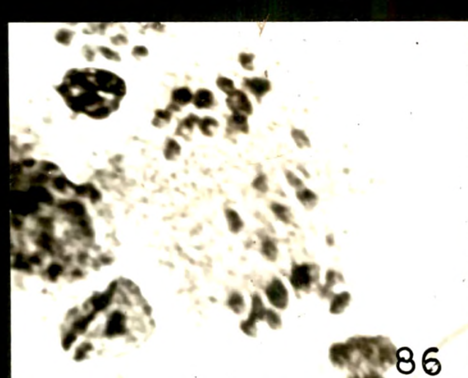
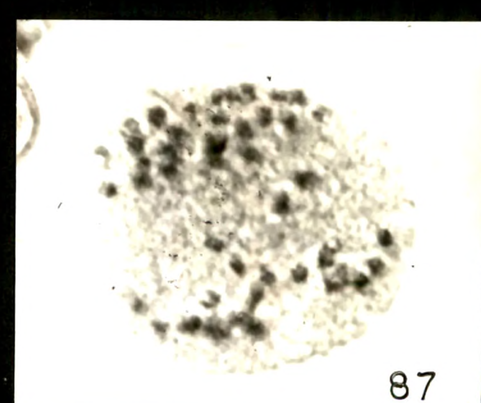


86



87

PL. 2:18

Table 2:13. Comparison of the somatic chromosomes of the populations of Physalis minima L.

Populations	Somatic number (2n)	n m Types		S M Type	n s m Types			Chromosome with secondary constriction Types		Chromosome with satellite Types			Absolute length in μ	Mean length in μ	L/S
		D	G	E	C	F	H	$F^{S'}$	$H^{S'}$	D^S	F^S	H^S			
Coll.No.37	48	8	4	2	2	24	8	-	-	2	2	-	58.119	1.21	2.10
Coll.No.42	48	-	20	-	-	4	24	2	2	-	-	6	39.951	0.83	2.18

for the species is known from the works of Janaki Ammal (1935), Oinuma (1945), Stebbins & Paddock (1949), Gottschalk (1954), Okabe (1955), Karschon, Runwald & Weinstein (1979). Jörgensen (1928), Oinuma (1945) and Zutshi & Kaul (1974) have reported n = 24 for the taxon. Both n and 2n numbers reported earlier are confirmed in the present investigation.

Coll. No. 31 :

Karyotype formula : 2n = 48 + 2B = $C_8+D_6+F^S_4+F_{22}+G_2+H_6$.

(Table 2:14)

The somatic complement of the species consists of 20 pairs of chromosomes with nearly submedian and 4 pairs with nearly median centromeres: are represented by 4 pairs of C-type, 13 pairs of F-type and 3 pairs with H-type. While those having nearly median centromeres are represented by 3 pairs of D-type and only one pair of G-type. The chromosomes are medium to short sized ranging in length between 1.486 to 3.153 µ with mean length of 1.22 µ. Both the pairs of satellited chromosomes belong to F-type. Presence of 2B-chromosomes is noticed in most of the plates analysed for the karyotypic study. The relative length values and TF% indicate the asymmetrical and smoothly graded nature of the karyotype. The value of L/S ratio 2.12 (Table 2:14) and Idiogram also indicate the same (Figs. 88, 89, 90).

Pl. 2:19

Solanum villosum subsp. *villosum*

Coll. No. 31 :

(Mitosis)

Fig. 88 - Camera lucida drawing of somatic metaphase plate.

Fig. 89 - Idiogram.

Fig. 90 - Photomicrograph of somatic metaphase plate .

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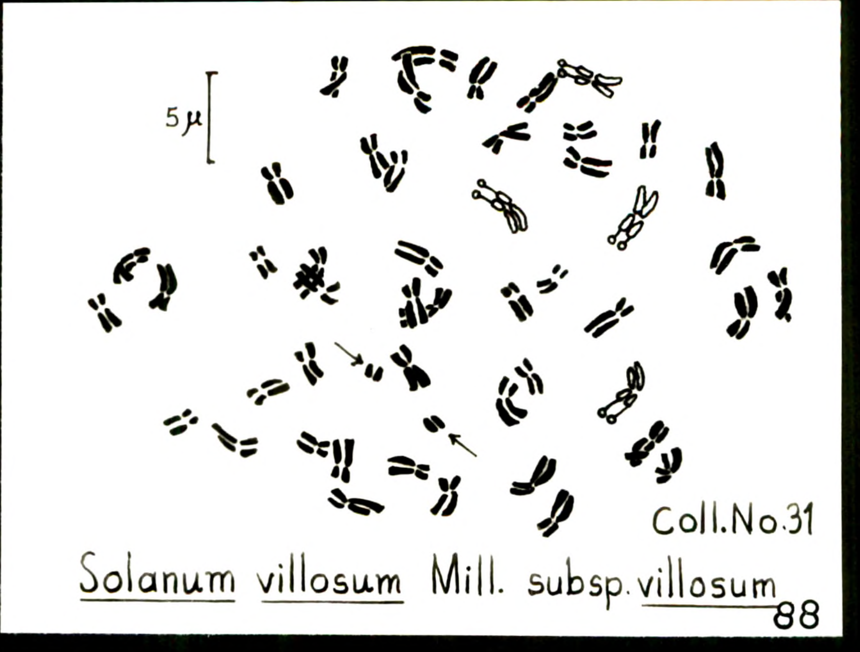
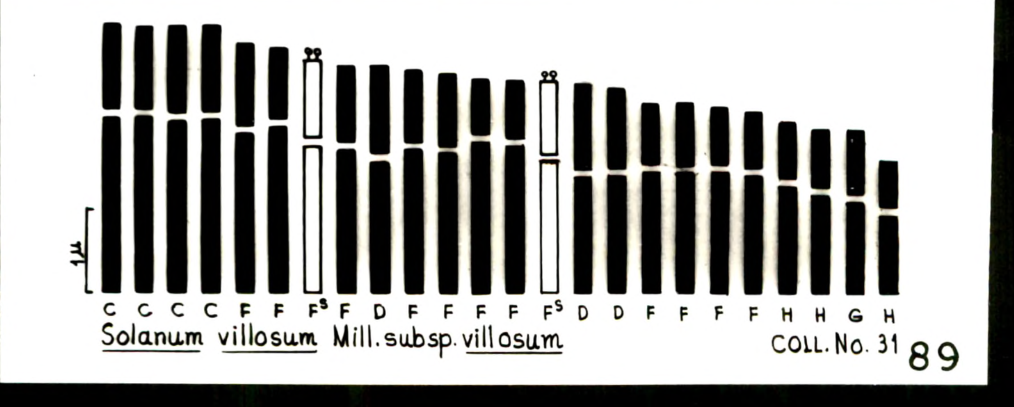

5μ
Coll. No. 31
Solanum villosum Mill. subsp. villosum
88


1μ
C C C C F F F^S F D F F F F F^S D D F F F F H H G H
Solanum villosum Mill. subsp. villosum
COLL. No. 31
89


90

PL. 2:19

Table 2:14. Details of the karyotype analysis of <u>Solanum villosum</u> Mill. subsp. <u>villosum</u> (Coll. No. 31)

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total Length	R_1	R_2			
1, 2	2.117	+	1.036	=	3.153	0.48	2.04	100	nsm	C
3, 4	2.117	+	0.991	=	3.108	0.46	2.18	98	nsm	C
5, 6	2.072	+	1.036	=	3.108	0.50	2.0	98	nsm	C
7, 8	2.072	+	0.946	=	3.018	0.45	2.19	95	nsm	C
9,10	1.892	+	0.991	=	2.883	0.52	1.90	91	nsm	F
11,12	1.981	+	0.856	=	2.837	0.43	2.31	89	nsm	F
13,14	1.756	+	0.946	=	2.702	0.53	1.85	85	nsm	F^S
15,16	1.711	+	0.901	=	2.612	0.52	1.89	82	nsm	F
17,18	1.576	+	1.036	=	2.612	0.65	1.52	82	nm	D
19,20	1.711	+	0.856	=	2.567	0.50	1.99	81	nsm	F
21,22	1.666	+	0.856	=	2.522	0.51	1.94	79	nsm	F
23,24	1.801	+	0.631	=	2.432	0.35	2.85	77	nsm	F
25,26	1.756	+	0.676	=	2.432	0.38	2.59	77	nsm	F
27,28	1.576	+	0.856	=	2.432	0.48	2.06	77	nsm	F^S
29,30	1.396	+	0.991	=	2.387	0.70	1.40	75	nm	D
31,32	1.396	+	0.946	=	2.342	0.67	1.47	74	nm	D
33,34	1.441	+	0.721	=	2.162	0.50	1.99	68	nsm	F
35,36	1.441	+	0.721	=	2.162	0.50	1.99	68	nsm	F
37,38	1.441	+	0.676	=	2.117	0.46	2.13	67	nsm	F
39,40	1.396	+	0.676	=	2.072	0.48	2.06	65	nsm	F
41,42	1.261	+	0.676	=	1.937	0.53	1.86	61	nsm	H
43,44	1.170	+	0.676	=	1.846	0.57	1.73	58	nsm	H
45,46	1.081	+	0.765	=	1.846	0.70	1.41	58	nm	G
47,48	0.946	+	0.540	=	1.486	0.57	1.75	47	nsm	H
	38.773		20.002		58.775					

L/S = 2.12

Mean length = 1.22 μ

T F % = 34.03 %

Karyotype formula = 2n = 48+ 2B = $C_8 + D_6 + F^S_4 + F_{22} + G_2 + H_6$

In contrast to the earlier analysis of the karyotype of the species by Oinuma (1945), presently analysed population showed the presence of 1 or 2 B-chromosomes.

Meiotic studies revealed the presence of 24 distinct bivalents at diakinesis and their regular behaviour in subsequent stages (Figs. 91, 92, 95, 98). However, in few PMCs, abnormalities such as occurrence of laggards and bridge formation at telophase I (Figs. 93 & 94) and occurrence of lagging B-chromosomes at telophase II (Figs. 96, 97) are noticed. These abnormalities were not recorded in the earlier work of Jörgensen (1928). The determined pollen fertility of the species is 97.73%.

<u>Solanum</u> <u>villosum</u> Mill. subsp. <u>puniceum</u> (Kirschleger) Edmonds

Vilmorin & Simonet (1927, 1928), Westergaard (1948) have reported the chromosome number for the somatic complement as 2n = 48 for the taxon. Jörgensen (1928) has reported both, somatic and gametic numbers as 48 and 24, respectively. The haploid number n = 24 has also been confirmed by Zutshi & Kaul (1974). In contrast to these reports, Oinuma (1945) has reported n = 12 and 2n = 24 for the species, meaning thereby that the population analysed was a diploid one, in contrast to others which happened to be tetraploid. In the present study of the species 2n = 48 and n = 24 are encountered.

Pl. 2:20

Solanum villosum subsp. villosum

Coll. No. 31 :

(Meiosis)

Fig. 91 - PMC showing equal distribution (24:24) of chromosomes at anaphase I along with B-chromosomes.

Fig. 92 - " " metaphase II (Polar view).

Fig. 95 - " " normal distribution of chromosomes and presence of B-chromosomes at telophase II.

Fig. 93 - " " laggards at telophase I.

Fig. 94 - " " bridge and stickiness of few bivalents at anaphase I.

Fig. 96 - " " laggards and stickiness of chromosomes at telophase II.

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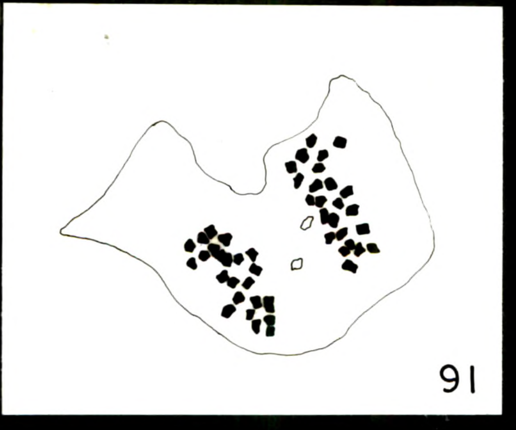

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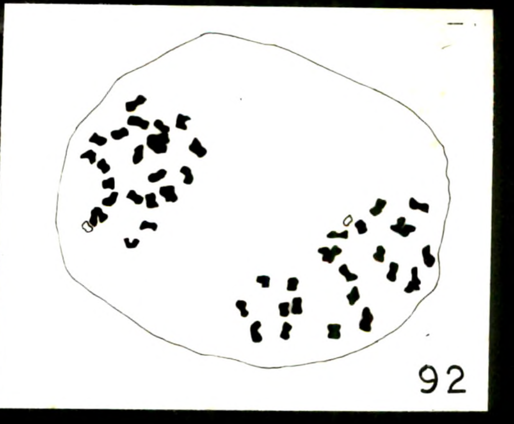

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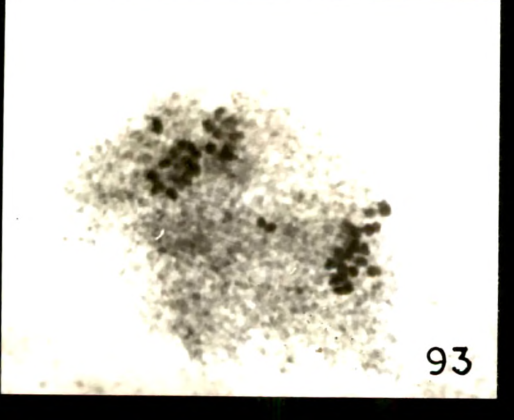

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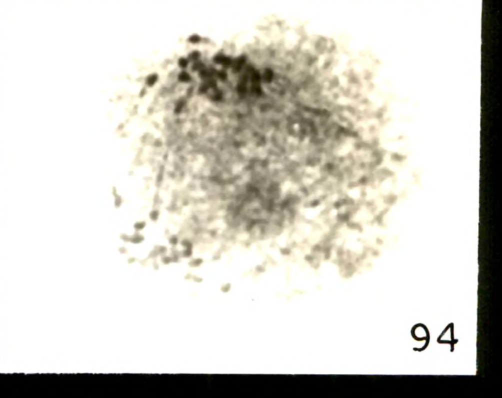

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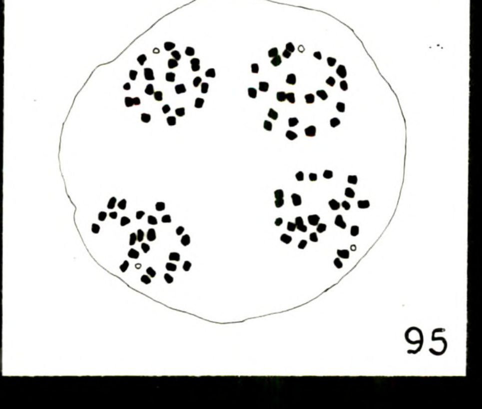

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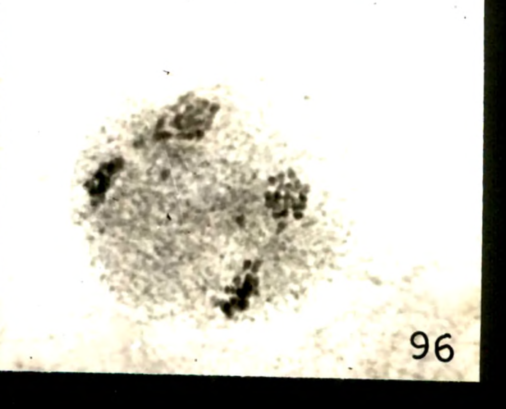

96

PL. 2:20

Coll. No. 32 :

Karyotype formula : $2n = 48 = D_6+F_2^{S'}+F_2^{S}+F_{20}+G_8+H_2^{S}+H_8$

(Table 2:15)

The chromosomes within the somatic complement are medium to short sized ranging in length from 1.381 to 2.881 μ. Chromosomes of the complement are distributed in 4 types viz., D, F, G & H-types, having nearly median or nearly submedian centromeres. As many as 17 pairs (F & H-types) having nearly submedian and only 7 pairs (D & G-types) having nearly median centromeres, are observed. Within the complement there are 2 pairs of satellited and one pair of secondarily constricted chromosomes having secondary constrictions on long arms. The evolved nature of the karyotype is reflected in the calculated values of TF% (35.50%) and L/S ratio (2.08). Asymmetrical and graded nature is also evident in the idiogram (Figs. 99, 100, 101).

During meiosis 24 distinct bivalents are observed at diakinesis (Fig. 102). At metaphase II equal distribution (24:24) of chromosomes and their duplication is observed (Fig. 103). Subsequent stages show normal behaviour of chromosomes resulting in the formation of normal isobilateral tetrad (Fig. 105). However, in very few pollen mother cells, unequal distribution because of few non synchronised chromosomes is observed at telophase I (Fig. 104). 93.45% is the determined pollen fertility for the species.

Pl. 2:21

Solanum villosum subsp. *villosum*

Coll. No. 31 (Contd.) :

(Meiosis)

Fig. 97 - Camera lucida drawing of PMC showing laggards at telophase II.

Fig. 98 - Camera lucida drawing of PMC showing isobilateral tetrad.

Solanum villosum subsp. *puniceum*

Coll. No. 32 :

(Mitosis)

Fig. 99 - Camera lucida drawing of somatic metaphase plate.

Fig.100 - Idiogram.

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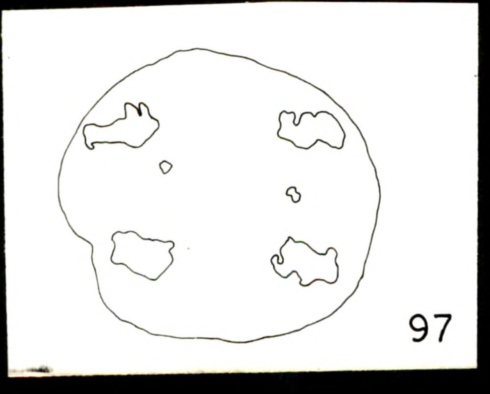
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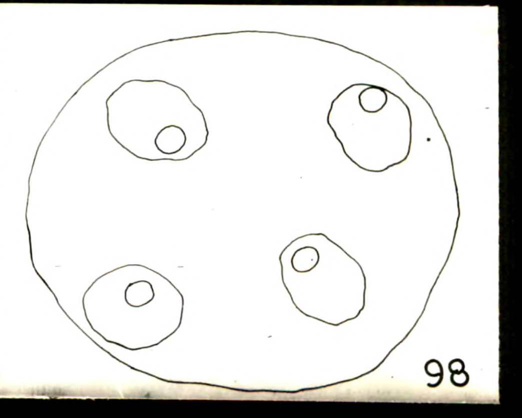
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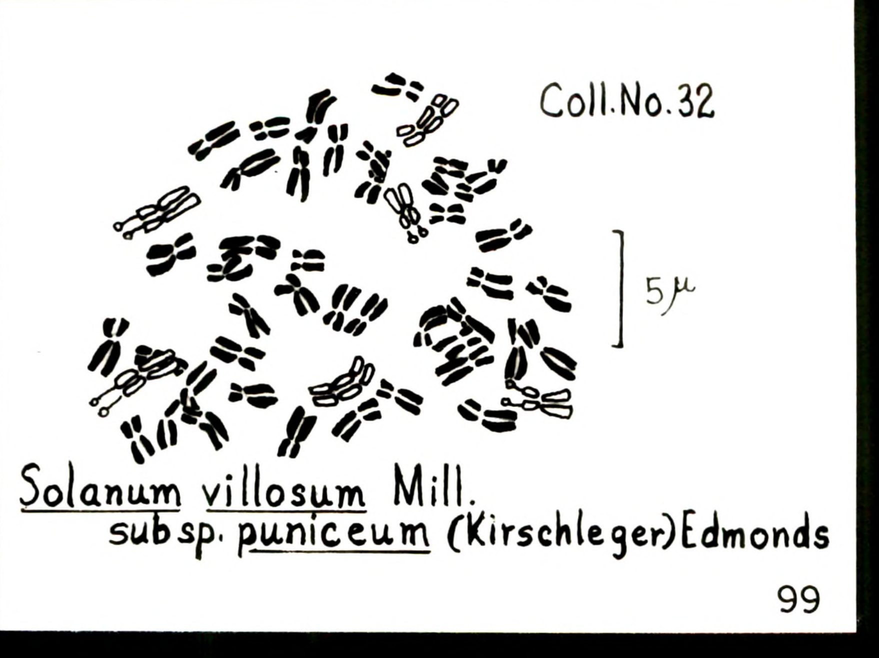
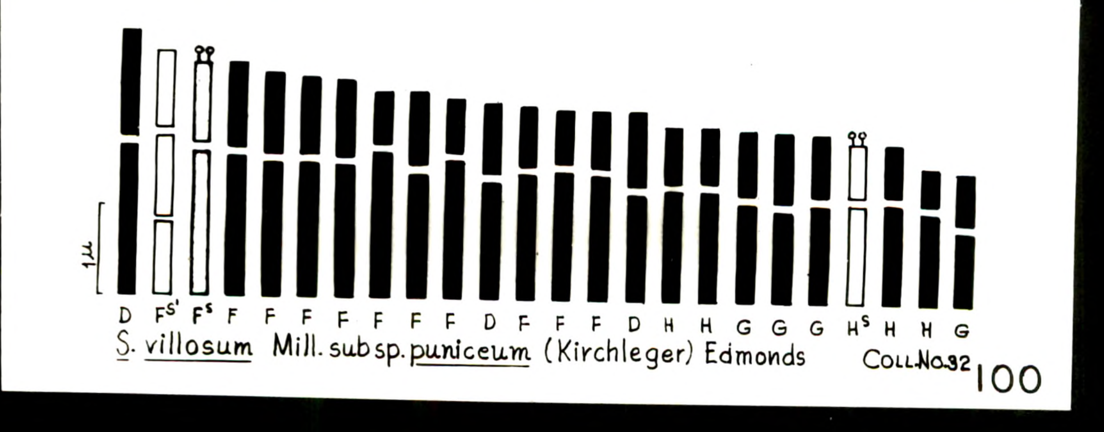

Coll.No.32
5μ
Solanum villosum Mill.
subsp. puniceum (Kirschleger) Edmonds
99


1μ
D F F F F F F F F F D F F F D H H G G G H H H G
S. villosum Mill. subsp. puniceum (Kirchleger) Edmonds
Coll.No.32
100

PL. 2: 21

Pl. 2:22

Solanum villosum subsp. puniceum

Coll. No. 32 (Contd.) :

(Mitosis)

Fig. 101 - Photomicrograph of somatic metaphase plate.

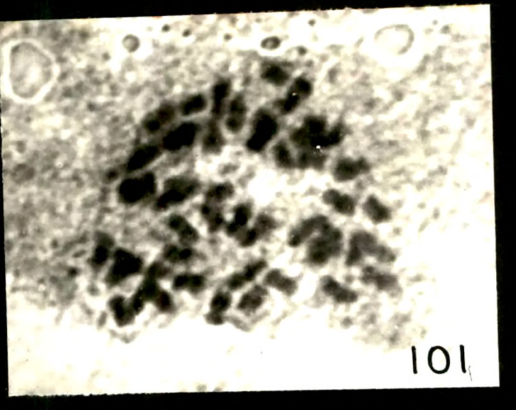
(Meiosis)

Fig. 102 - PMC showing 24 bivalents at early diakinesis.

Fig. 103 - " " 24:24 distribution of chromosomes and their duplication at metaphase II.

Fig. 104 - " " unequal distribution at telophase I.

Fig. 105 - " " normal tetrad formation.



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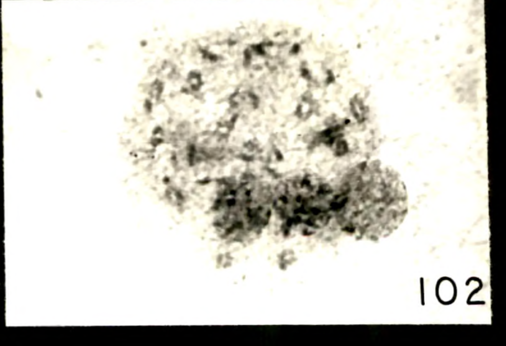

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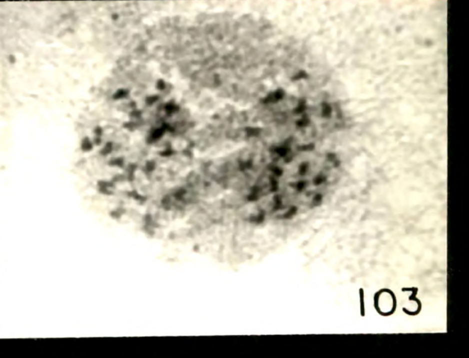

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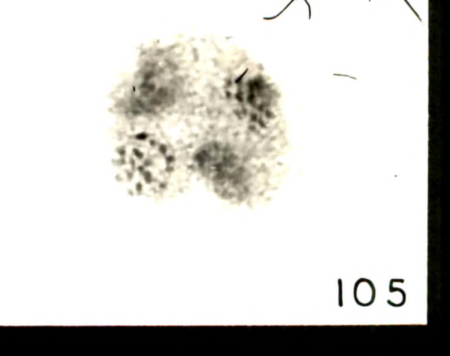
104



105

PL. 2:22

Table 2:15. Details of the karyotype analysis of Solanum villosum subsp. puniceum (Kirschleger) Edmonds (Coll. No. 32).

Chromosome pair	Length in μ: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.697	+	1.184	=	2.881	0.69	1.43	100	nm	D
3, 4	+0.829 0.907	+	0.868	=	2.604	0.50	2.00	90	nsm	$F^{S'}$
5, 6	1.618	+	0.907	=	2.525	0.56	1.78	87	nsm	F^S
7, 8	1.578	+	0.947	=	2.525	0.60	1.66	87	nsm	F
9,10	1.500	+	0.907	=	2.407	0.60	1.65	83	nsm	F
11,12	1.500	+	0.868	=	2.368	0.58	1.73	82	nsm	F
13,14	1.460	+	0.868	=	2.328	0.59	1.68	80	nsm	F
15,16	1.618	+	0.592	=	2.210	0.36	2.73	76	nsm	F
17,18	1.381	+	0.829	=	2.210	0.60	1.66	76	nsm	F
19,20	1.539	+	0.592	=	2.131	0.38	2.60	73	nsm	F
21,22	1.302	+	0.789	=	2.091	0.61	1.65	72	nm	D
23,24	1.381	+	0.671	=	2.052	0.48	2.05	71	nsm	F
25,26	1.420	+	0.592	=	2.012	0.41	2.39	69	nsm	F
27,28	1.381	+	0.631	=	2.012	0.46	2.19	69	nsm	F
29,30	1.183	+	0.829	=	2.012	0.70	1.42	69	nm	D
31,32	1.223	+	0.631	=	1.854	0.51	1.94	64	nsm	H
33,34	1.223	+	0.631	=	1.854	0.51	1.94	64	nsm	H
35,36	1.105	+	0.710	=	1.815	0.64	1.55	62	nm	G
37,38	1.026	+	0.789	=	1.815	0.77	1.30	62	nm	G
39,40	1.105	+	0.671	=	1.776	0.61	1.65	61	nm	G
41,42	1.105	+	0.592	=	1.697	0.53	1.86	58	nsm	H^S
43,44	1.105	+	0.592	=	1.697	0.53	1.86	58	nsm	H
45,46	1.026	+	0.394	=	1.420	0.38	2.60	49	nsm	H
47,48	0.829	+	0.552	=	1.381	0.66	1.50	47	nm	G
	32.041		17.636		49.677					

L/S = 2.08

Mean length = 1.03 μ

T F % = 35.50%

Karyotype formula = 2n= 48 = $D_6 + F_2^{S'} + F_2^S + F_{20} + G_8 + H_2^S + H_8$

Solanum chenopodioides Lam.

For the taxon earlier reports are 2n = 24 by Vilmorin & Simonet (1927, 1928), Ratera (1944), Westergaard (1948), Fernades (1960); 2n = 48 by Baylis (1958); n = 24 by Zutshi & Kaul (1974); 2n = 72 by Gottschalk (1954). While Kagawa (1937) has reported 2n = 24, 36 & 48 for the different populations of the species analysed. In the present study 2n = 72 and n = 36 are encountered.

Coll. No. 33 :

Karyotype formula : $2n = 72 + 4B = C_2 + D^S_2 + D_{18} + F_{28} + G_{10} + H^S_4 + H_8$

(Table 2:16)

The analysis of the somatic complement reveals the presence of 21 pairs with nearly submedian and 15 pairs with nearly median centromeres. The chromosomes within the complement are medium to short sized varying in length from 1.576 μ to 3.197 μ with a mean length of 1.09 μ. 1 pair of C-type, 14 pairs of F-type and 6 pairs of H-type represent chromosomes having nearly submedian centromeres while, 10 pairs of D-type and 5 pairs of G-type are with nearly median centromeres. The noteworthy features of the complement are, presence of 3 pairs of satellited chromosomes (D^S & H^S-types) and the occurrence of 4 accessory chromosomes (B-chromosome).

Table 2:16. Details of the karyotype analysis of Solanum chenopodioides Lam. (Coll. No. 33).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	2.161	+	1.036	=	3.197	0.47	2.08	100	nsm	C
3, 4	1.801	+	1.036	=	2.837	0.57	1.73	88	nsm	F
5, 6	1.891	+	0.856	=	2.747	0.45	2.20	85	nsm	F
7, 8	1.801	+	0.946	=	2.747	0.52	1.90	85	nsm	F
9,10	1.621	+	1.081	=	2.702	0.66	1.49	84	nm	D
11,12	1.711	+	0.901	=	2.612	0.52	1.89	81	nsm	F
13,14	1.711	+	0.856	=	2.567	0.50	1.99	80	nsm	F
15,16	1.666	+	0.856	=	2.522	0.51	1.94	78	nsm	F
17,18	1.576	+	0.946	=	2.522	0.60	1.66	78	nsm	F
19,20	1.531	+	0.946	=	2.477	0.61	1.61	77	nm	D
21,22	1.576	+	0.856	=	2.432	0.54	1.84	76	nsm	F
23,24	1.666	+	0.676	=	2.342	0.40	2.46	73	nsm	F
25,26	1.216	+	1.081	=	2.297	0.88	1.12	71	nm	D
27,28	1.351	+	0.856	=	2.207	0.63	1.57	69	nm	D
29,30	1.441	+	0.676	=	2.117	0.46	2.13	66	nsm	F
31,32	1.441	+	0.676	=	2.117	0.46	2.13	66	nsm	F
33,34	1.306	+	0.811	=	2.117	0.62	1.61	66	nm	D
35,36	1.216	+	0.901	=	2.117	0.74	1.34	66	nm	D
37,38	1.396	+	0.676	=	2.072	0.48	2.06	64	nsm	F
39,40	1.261	+	0.811	=	2.072	0.64	1.55	64	nm	D^S

Contd....

Table 2:16. Contd.

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
41,42	1.261	+ 0.811	= 2.072	0.64	1.55	64	nm	D
43,44	1.441	+ 0.586	= 2.027	0.40	2.45	63	nsm	F
45,46	1.441	+ 0.586	= 2.027	0.40	2.45	63	nsm	F
47,48	1.261	+ 0.766	= 2.027	0.61	1.64	63	nm	D
49,50	1.216	+ 0.811	= 2.027	0.66	1.49	63	nm	D
51,52	1.261	+ 0.721	= 1.982	0.57	1.74	61	nsm	H
53,54	1.216	+ 0.766	= 1.982	0.62	1.58	61	nm	G
55,56	1.171	+ 0.811	= 1.982	0.69	1.44	61	nm	G
57,58	1.216	+ 0.721	= 1.937	0.59	1.68	60	nsm	H^S
59,60	1.261	+ 0.630	= 1.891	0.49	2.00	59	nsm	H^S
61,62	1.216	+ 0.630	= 1.846	0.51	1.93	57	nsm	H
63,64	1.081	+ 0.676	= 1.757	0.62	1.59	54	nm	G
65,66	1.216	+ 0.450	= 1.666	0.37	2.70	52	nsm	H
67,68	0.945	+ 0.721	= 1.666	0.76	1.31	52	nm	G
69,70	1.036	+ 0.585	= 1.621	0.56	1.77	50	nsm	H
71,72	0.946	+ 0.630	= 1.576	0.66	1.50	49	nm	G
	50.525	28.381	78.906					

L/S = 2.02

Mean length = 1.09 μ

T F % = 35.95%

Karyotype formula = 2n= 72+4 B = $C_2 + D^S_2 + D_{18} + F_{28} + G_{10} + H^S_4 + H_8$

The evolved nature of the karyotype is evidenced by the determined values of L/S ratio (2.02) and TF% (35.95%). The idiogram reveals the evolved nature of the species which show smooth gradation except in the beginning (Figs. 106, 107, 108).

In general meiotic behaviour of chromosomes is observed at early and late diakinesis (Figs. 109 & 111), metaphase I (Fig. 110) and at early anaphase I (Fig. 112). Occurrence of B-chromosomes, recorded in somatic complement is also confirmed by their presence in PMCs. at stages of meiotic division. Occurrence of laggards (probably B-chromosome) at telophase I and II (Figs. 114 & 115) and groupings of bivalents at metaphase I (Fig. 116) are the 2 abnormalities observed. The determined pollen fertility is 92.53% for the species.

Solanum scabrum Mill.

The present analysis confirms the earlier reports of 2n = 72 by Vilmorin & Simonet (1927, 1928), Jörgensen & Crane (1927), Oinuma (1945), Westergaard (1948) for the species. Haploid number n = 36 reported by Oinuma (1945) is also confirmed.

Coll. No. 36 :

Karyotype formula : $2n = 72 = B_2+C_4+D_8+E_2+F_{24}+G_2^S+G_8+H_4^S+H_{18}$

(Table 2:17)

Pl. 2:23

Solanum chenopodioides

Coll. No. 33 :

(Mitosis)

Fig. 106 - Camera lucida drawing of metaphase plate. →denotes B-chromosomes.

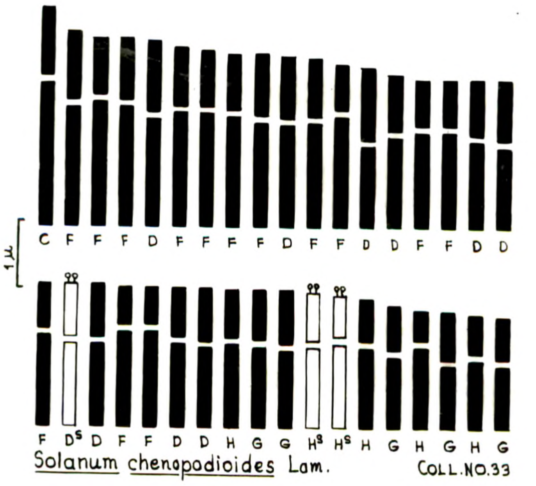
Fig. 107 - Idiogram.

Fig. 108 - Photomicrograph of somatic metaphase plate.

Contd...

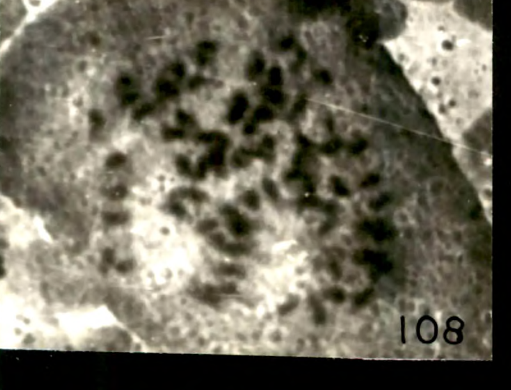
Solanum chenopodioides Lam. Coll.No.33

106



Solanum chenopodioides Lam. COLL.NO.33

107



108

PL. 2 : 23

Pl. 2:24

Solanum chenopodioides

Coll. No. 33 :

(Meiosis)

Fig. 109 - PMC showing 36 distinct bivalents at diakinesis.

Fig. 111 - " " 36 bivalents at late diakinesis.

Fig. 110 - " " metaphase I.

Fig. 112 - " " anaphase I (early).

Fig. 113 - " " equal distribution (36:36) of chromosomes at metaphase II. (Polar view).

Fig. 114 - " " laggards at telophase I.

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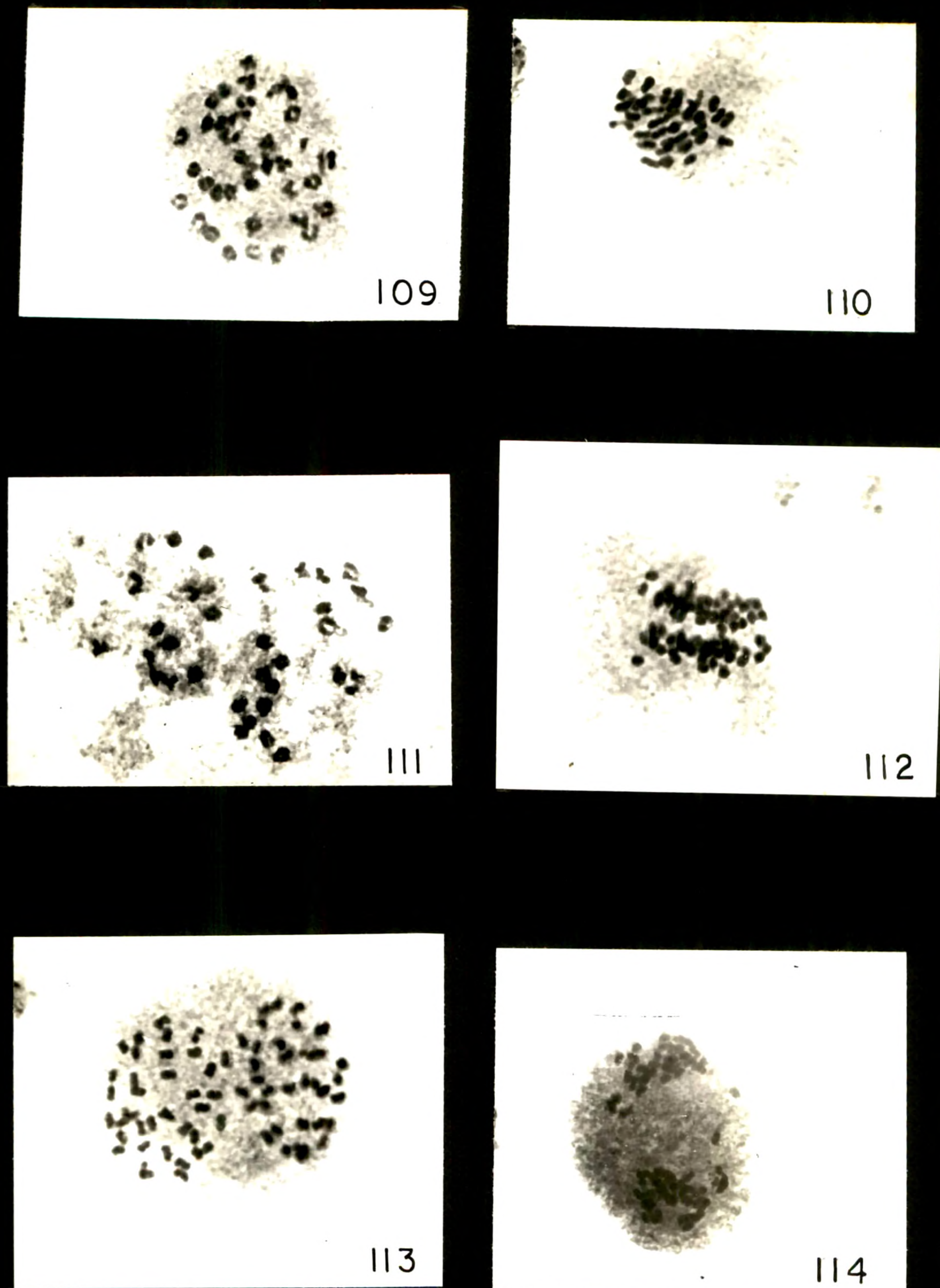

PL. 2:24

Table 2:17. Details of the karyotype analysis of <u>Solanum scabrum</u> Mill. (Coll. No. 36).

Chromosome pair	Length in µ			Arm Ratios		Relative length	Centromere	Type
	Long Arm	+ Short Arm	= Total length	R_1	R_2			
1, 2	2.297	+ 1.351	= 3.648	0.58	1.70	100	nsm	C
3, 4	2.386	+ 1.126	= 3.512	0.47	2.11	96	nsm	C
5, 6	2.026	+ 1.441	= 3.467	0.71	1.40	95	nm	B
7, 8	1.801	+ 0.901	= 2.702	0.50	1.99	74	nsm	F
9,10	1.801	+ 0.811	= 2.612	0.45	2.22	71	nsm	F
11,12	1.756	+ 0.856	= 2.612	0.48	2.05	71	nsm	F
13,14	1.711	+ 0.811	= 2.522	0.47	2.10	69	nsm	F
15,16	1.756	+ 0.721	= 2.477	0.41	2.43	67	nsm	F
17,18	1.441	+ 0.946	= 2.387	0.65	1.52	65	nm	D
19,20	1.351	+ 1.036	= 2.387	0.76	1.30	65	nm	D
21,22	1.441	+ 0.901	= 2.342	0.62	1.59	64	nm	D
23,24	1.441	+ 0.856	= 2.297	0.59	1.68	62	nsm	F
25,26	1.531	+ 0.675	= 2.206	0.44	2.26	60	nsm	F
27,28	1.622	+ 0.540	= 2.162	0.33	3.0	59	SM	E
29,30	1.486	+ 0.676	= 2.162	0.45	2.19	59	nsm	F
31,32	1.441	+ 0.721	= 2.162	0.50	1.99	59	nsm	F
33,34	1.351	+ 0.811	= 2.162	0.60	1.66	59	nsm	F
35,36	1.306	+ 0.856	= 2.162	0.65	1.52	59	nm	D
37,38	1.486	+ 0.631	= 2.117	0.42	2.35	58	nsm	F
39,40	1.396	+ 0.631	= 2.027	0.45	2.12	55	nsm	F

Contd....

Table 2:17. Contd.

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
41,42	1.351	+ 0.631	= 1.982	0.46	2.14	54	nsm	H
43,44	1.261	+ 0.721	= 1.982	0.57	1.74	54	nsm	H
45,46	1.306	+ 0.631	= 1.937	0.48	2.06	53	nsm	H
47,48	1.216	+ 0.721	= 1.937	0.59	1.68	53	nsm	H
49,50	1.126	+ 0.811	= 1.937	0.72	1.38	53	nm	G
51,52	1.170	+ 0.721	= 1.891	0.61	1.62	51	nm	G
53,54	1.216	+ 0.631	= 1.847	0.51	1.92	50	nsm	H^S
55,56	1.081	+ 0.766	= 1.847	0.70	1.41	50	nm	G^S
57,58	1.081	+ 0.721	= 1.802	0.66	1.49	49	nm	G
59,60	1.126	+ 0.631	= 1.757	0.56	1.78	48	nsm	H
61,62	1.081	+ 0.585	= 1.666	0.54	1.84	45	nsm	H
63,64	1.081	+ 0.540	= 1.621	0.49	2.0	44	nsm	H
65,66	0.990	+ 0.631	= 1.621	0.63	1.56	44	nm	G
67,68	1.081	+ 0.495	= 1.576	0.45	2.18	43	nsm	H^S
69,70	0.901	+ 0.540	= 1.441	0.59	1.66	39	nsm	H
71,72	0.901	+ 0.450	= 1.351	0.49	2.0	37	nsm	H
	50.796	27.524	78.320					

L/S = 2.70

Mean length = 1.08 μ

T F % = 35.14 %

Karyotype formula = 2n = 72 = $B_2+C_4+D_8+E_2+F_{24}+G_2^S+G_8+H_4^S+H_{18}$

72 chromosomes of the somatic complement are represented by 10 pairs (B, D & G-types) having nearly median, 25 pairs (C, F & H-types) having nearly submedian and only one pair, E-type with exactly submedian centromeres. Of the 3 pairs of satellited chromosomes, present within the complement, 2 pairs belong to H-type and one pair to G-type. Advanced and evolved nature of the karyotype is evident in its having as many as 25 pairs with nearly submedian centromeres and values of L/S ratio i.e. 2.70 & TF%, which is 35.14%. The longest pair within the complement is 3.648 μ in length and the shortest pair is of 1.351 μ length. Between these two extremes the length of other chromosome pairs show relatively smooth gradation and the same is evident in the idiogram (Figs. 117, 118, 119).

The study of pollen mother cells revealed the presence of 36 distinct bivalents both at diakinesis and metaphase I (Fig. 120, 122 and 121). But in few, at telophase I groups of non congressional chromosomes, and stickiness of the chromosomes with or without laggards are noticed. Tetrads of both linear and isobilateral types are observed. During the formation of tetrads i.e. at late telophase II laggards are seen (Figs. 123 and 124). The species showed pollen fertility of 97.80%.

<u>Solanum</u> <u>americanum</u> Mill.

But for, Löve's (1954) report of 2n = 48 all other workers

Pl. 2:25

Solanum chenopodioides

Coll. No. 33 (Contd.)

(Meiosis)

Fig. 115 - PMC showing unequal distribution of chromosomes and presence of laggards.

Fig. 116 - " " groupings of bivalents at metaphase I.

Solanum scabrum

Coll. No. 36 :

Fig. 117 - Camera lucida drawing of the somatic metaphase plate.

Fig. 118 - Photomicrograph of the somatic metaphase plate.

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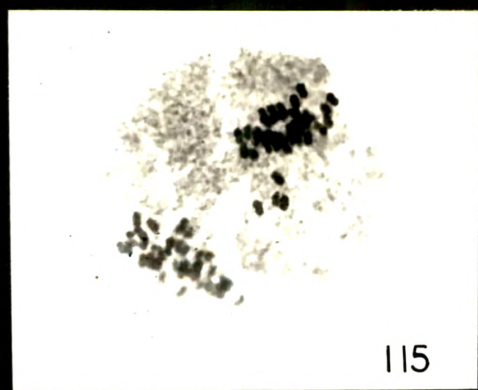

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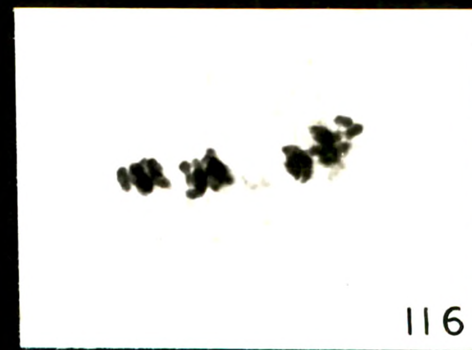

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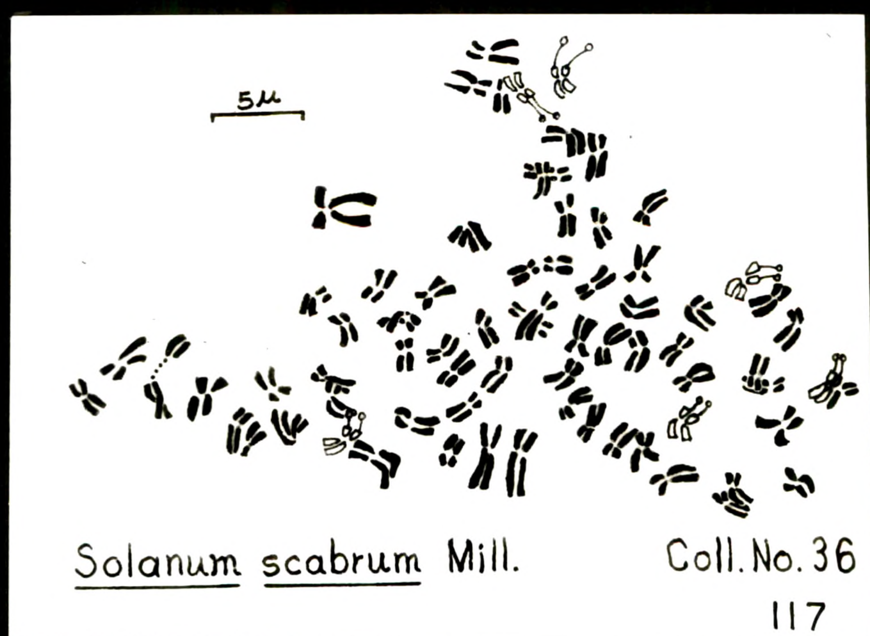
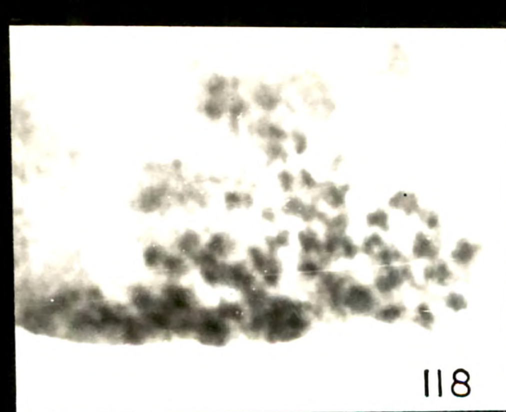


Solanum scabrum Mill. Coll. No. 36

117



118

2:25

PL. 2 : 25

Pl. 2:26

Solanum scabrum

Coll. No. 36:

(Mitosis)

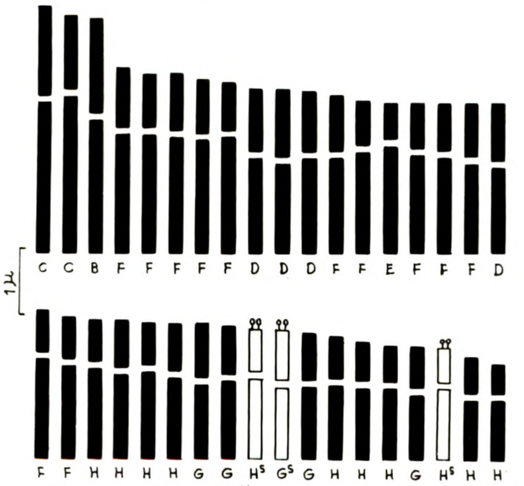
Fig. 119 - Idiogram.

(Meiosis)

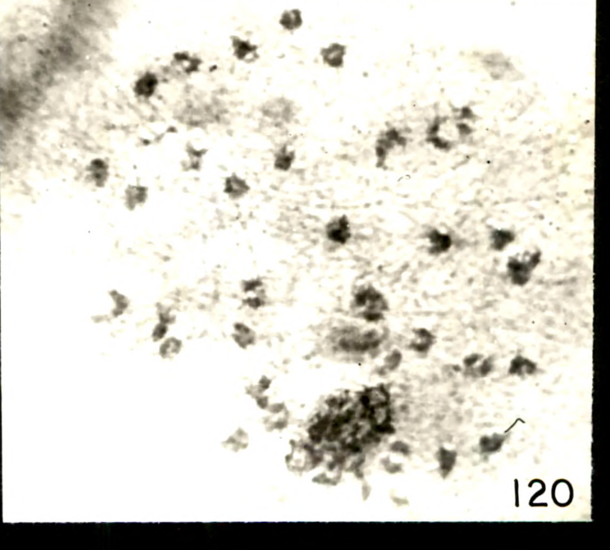
Fig. 120 - PMC showing 36 bivalents at diakinesis.

Fig. 121 - " " 36 bivalents at metaphase I (side view).

Fig. 122 - " " late diakinesis.



Solanum scabrum Mill Coll.No.36
119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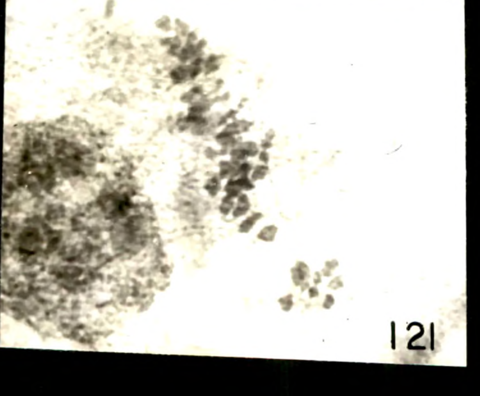
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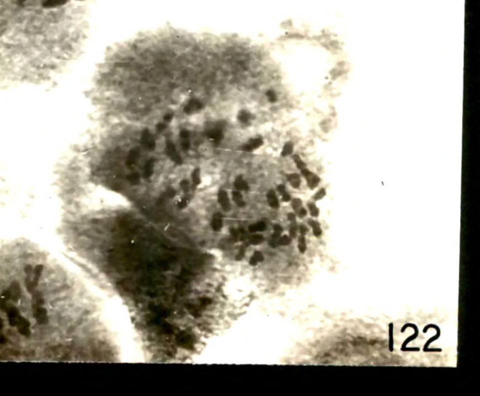
122

PL. 2 : 26

viz., Stebbins & Paddok (1949), Mülligan (1961), Crompton & Basset (1976) have reported 2n = 24 for the species. Haploid and diploid numbers n = 12 and 2n = 24 are encountered in the present study.

Coll. No. 35 :

Karyotype formula : $2n = 24 = D_8+F^S_4+F_4+G^S_2+H_6$

(Table 2:18)

Medium to short sized chromosomes of the somatic complement are with 5 pairs (D & G-types) with nearly median and 7 pairs (F & H-types) with nearly submedian centromeres. Among the 3 pairs of satellited chromosomes present within the complement, 2 pairs F^S-type are with nearly submedian and one pair of G^S-type is with nearly median centromeres. Comparatively lesser value of L/S ratio and higher TF% depict the less asymmetrical nature of the karyotype. Smooth gradation of the same is also reflected in 'relative length' values and idiogram (Figs. 125,126,127).

Majority of the PMCs analysed showed regular meiotic behaviour. Both at diakinesis and metaphase I,12 distinct bivalents are observed (Figs. 128, 129). However, in few PMCs,early separation of few bivalents at metaphase I (Fig. 130), few non congressional chromosomes resulting in unequal distribution at telophase II (Fig. 131) which

Pl. 2:27

Solanum scabrum

Coll. No. 36:

(Meiosis)

Fig. 123 - PMC showing laggards at telophase II.

Fig. 124 - " " linear tetrad formation along with laggard.

Solanum americanum

Coll. No. 35 :

(Mitosis)

Fig. 125 - Camera lucida drawing of somatic metaphase plate.

Fig. 126 - Photomicrograph of the same.

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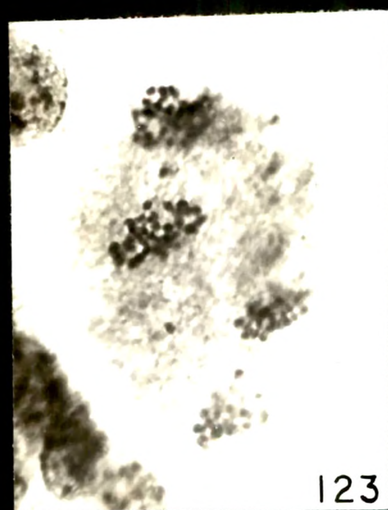

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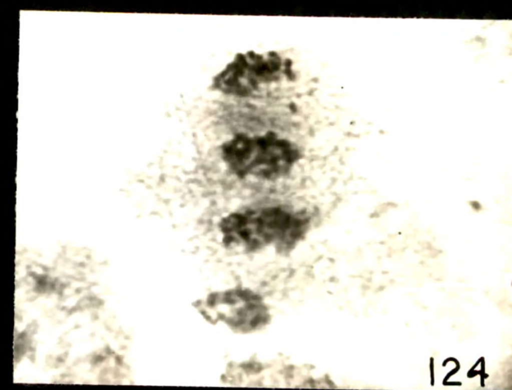

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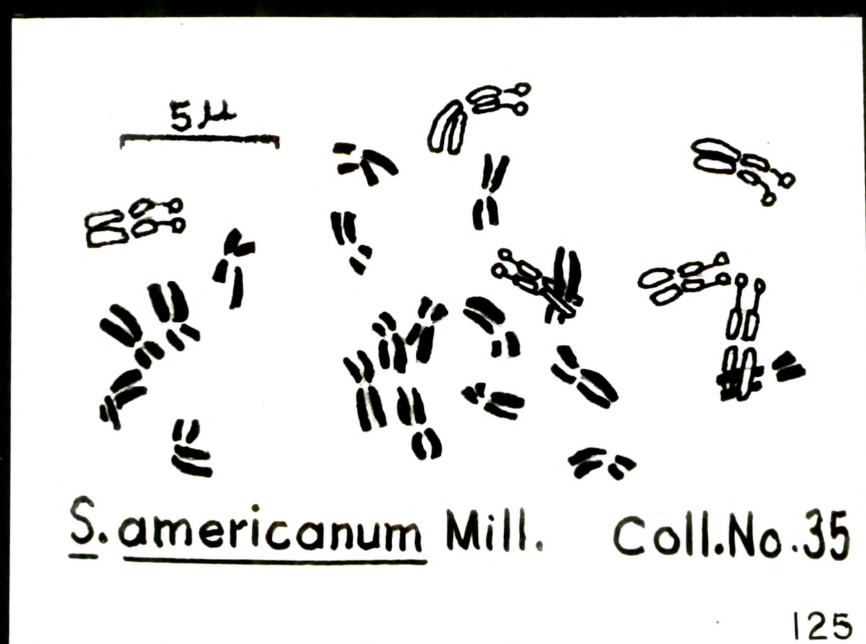

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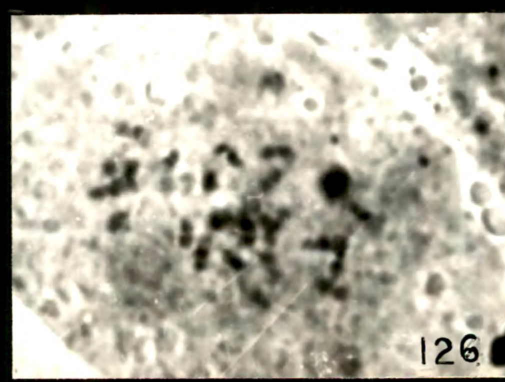

126

2:27

PL. 2 : 27

Pl. 2:28

Solanum americanum

Coll. No. 35 :

(Mitosis)

Fig. 127 - Idiogram

(Meiosis)

Fig. 128 - PMC showing 12 bivalents at diakinesis.

Fig. 129 - " " 12 distinct bivalents at metaphase I.

Fig. 130 - Camera lucida drawing of PMC showing separating bivalents at metaphase I.

Fig. 131 - " " drawing of PMC showing unequal distribution at telophase II.

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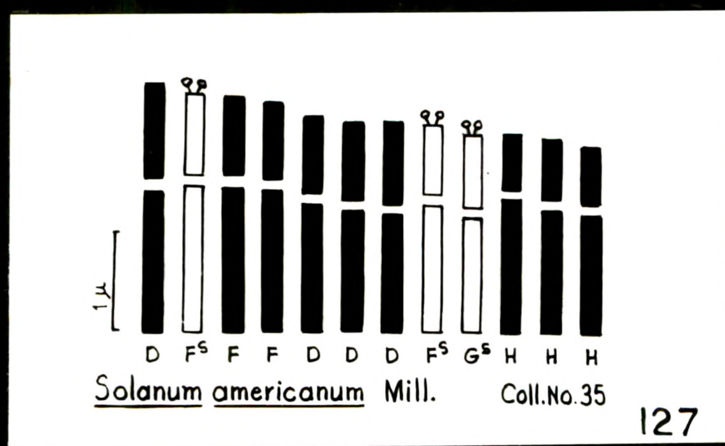

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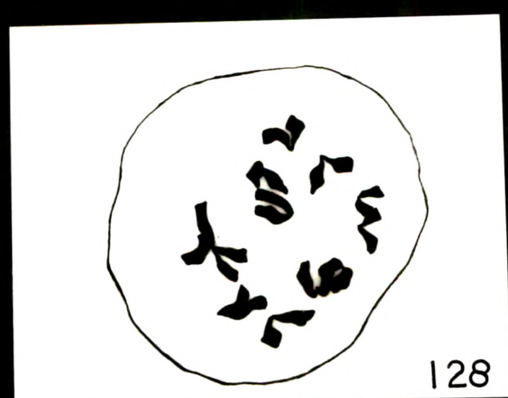
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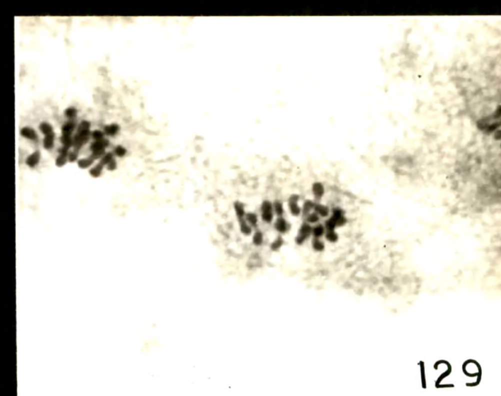
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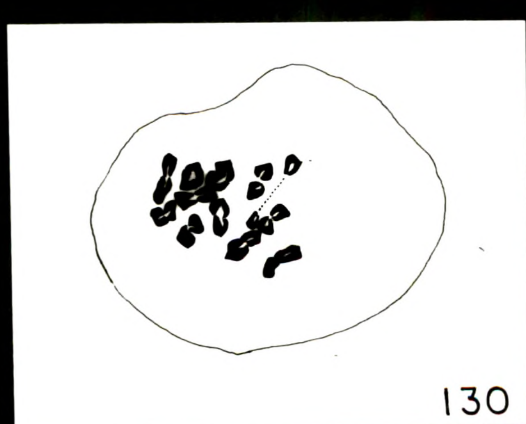
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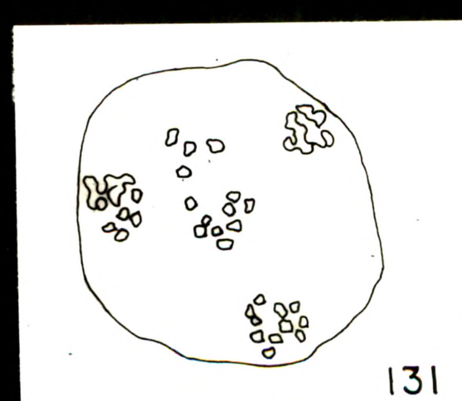
131

PL 2:28

Table 2:18. Details of the karyotype analysis of <u>Solanum americanum</u> Mill. (Coll. No. 35).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.441	+ 0.991	= 2.432	0.68	1.45	100	nm	D
3, 4	1.486	+ 0.856	= 2.342	0.57	1.73	96	nsm	F^S
5, 6	1.486	+ 0.811	= 2.297	0.54	1.83	94	nsm	F
7, 8	1.441	+ 0.811	= 2.252	0.56	1.77	92	nsm	F
9,10	1.306	+ 0.811	= 2.117	0.62	1.61	87	nm	D
11,12	1.261	+ 0.811	= 2.072	0.64	1.55	85	nm	D
13,14	1.216	+ 0.856	= 2.072	0.70	1.42	85	nm	D
15,16	1.306	+ 0.721	= 2.027	0.55	1.81	83	nsm	F^S
17,18	1.171	+ 0.765	= 1.936	0.65	1.53	79	nm	G^S
19,20	1.351	+ 0.585	= 1.936	0.43	2.30	79	nsm	H
21,22	1.261	+ 0.631	= 1.892	0.50	1.99	77	nsm	H
23,24	1.216	+ 0.585	= 1.801	0.48	2.07	74	nsm	H
	15.942	9.234	25.176					

L/S = 1.35

Mean length = 1.05 μ

T F % = 36.67%

Karyotype formula = 2n = 24 = $D_8 + F^S_4 + F_4 + G^S_2 + H_6$

probably result in formation of 5 distinct groups at subsequent stage (Fig. 133). Most of the PMCs show normal isobilateral tetrad but occasionally linear tetrad formation (Fig. 132) is seen. In spite of these abnormalities, pollen fertility is 98.34%.

Solanum roxburghii Dunal

All the previous investigators viz., Heiser et al. (1965, 1976) and Bhatt (1974) have reported 2n = 48 and the same is confirmed by the present findings of n = 24 and 2n = 48.

Coll. Nos. 6
and 22 :

Karyotype formula : $2n = 48 = E_2^{S'}+F_{12}+G_4+H_2^S+H_{28}$

(Table 2:19)

The somatic complement includes medium and short sized chromosome ranging in length from 1.182 μ to 2.881 μ with a mean length of 0.91 μ. The complement contains one pair of chromosome (E-type) with exactly submedian centromere. Out of remaining 23 pairs, 2 pairs are with nearly median (G-type) and 21 pairs with nearly submedian (F & H-types) centromeres. The karyotype is also characterised in its having a pair of

Table 2:19. Details of the karyotype analysis of Solanum roxburghii Dun. (Coll. No. 6).

Chromosome pair	Length in μ: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.846	+	1.035	=	2.881	0.56	1.78	100	nsm	F
3, 4	+0.665 +1.083	+	0.591	=	2.339	0.33	2.95	81	SM	$E^{S'}$
5, 6	1.674	+	0.665	=	2.339	0.39	2.51	81	nsm	F
7, 8	1.625	+	0.665	=	2.290	0.40	2.44	79	nsm	F
9,10	1.478	+	0.812	=	2.290	0.54	1.82	79	nsm	F
11,12	1.428	+	0.640	=	2.068	0.44	2.23	71	nsm	F
13,14	1.453	+	0.566	=	2.019	0.38	2.56	70	nsm	F
15,16	1.281	+	0.714	=	1.995	0.55	1.79	69	nsm	H
17,18	1.281	+	0.615	=	1.896	0.48	2.08	65	nsm	H
19,20	1.182	+	0.665	=	1.847	0.56	1.77	64	nsm	H
21,22	1.133	+	0.714	=	1.847	0.63	1.58	64	nm	G
23,24	0.985	+	0.788	=	1.773	0.80	1.25	61	nm	G
25,26	1.182	+	0.566	=	1.748	0.47	2.08	60	nsm	H
27,28	1.133	+	0.591	=	1.724	0.52	1.91	59	nsm	H
29,30	1.108	+	0.591	=	1.699	0.54	1.83	58	nsm	H^S
31,32	1.083	+	0.591	=	1.674	0.53	1.87	58	nsm	H
33,34	1.133	+	0.517	=	1.650	0.45	2.19	57	nsm	H
35,36	0.985	+	0.566	=	1.551	0.57	1.74	53	nsm	H
37,38	1.034	+	0.369	=	1.403	0.35	2.80	48	nsm	H
39,40	0.911	+	0.468	=	1.379	0.51	1.94	47	nsm	H
41,42	0.960	+	0.369	=	1.329	0.38	2.60	46	nsm	H
43,44	0.862	+	0.443	=	1.305	0.51	1.94	45	nsm	H
45,46	0.862	+	0.369	=	1.231	0.42	2.33	42	nsm	H
47,48	0.862	+	0.320	=	1.182	0.37	2.69	41	nsm	H
	29.229		14.230		43.459					

L/S = 2.43

Mean length = 0.91 μ

T F % = 32.73%

Karyotype formula = $2\ n = 48 = E_2^{S'} + F_{12} + G_4 + H_2^S + H_{28}$

satellited (H^S-type) and a pair of chromosome with secondary constriction on long arms. The determined value of TF% and L/S ratio for this collection are 32.73% and 2.43 respectively. The idiogram reveals the asymmetrical and more or less smoothly graded nature of the karyotype (Figs. 134, 135,136).

Coll. Nos. 18
and 24 :

Karyotype formula : $2n = 48 = D_2^{S'} + F_2 + G_8 + H_2^S + H_{34}$

(Table 2:20)

Karyotype of this collection grossly resembles the karyotype of previous coll. No. 6, in having more pairs with nearly submedian centromere, in showing the presence of equal number of satellited and secondarily constricted chromosomes. Moreover, the resemblance is also noticed in the calculated values of absolute length, mean length and L/S ratio (Table 2:21). However, this collection differs from coll. No. 6 in its having 5 pairs (D & G-types) of chromosomes with nearly median centromeres and 19 pairs (F & H-types) with nearly submedian centromeres. The chromosome pair having exactly submedian centromere, recorded in the previous collection is not observed in this population. But for the few above mentioned structural differences, the karyotypes and idiograms of the 2 collections (Figs. 134 & 135 and 137 & 138) are more or less comparable.

Pl. 2:29

Solanum americanum

Coll. No. 35 :

(Meiosis)

Fig. 132 - PMC showing linear tetrad.

Fig. 133 - " " 5 groups of chromosomes at telophase II.

Solanum roxburghii

Coll. No. 6 :

(Mitosis)

Fig. 134 - Camera lucida drawing of somatic metaphase plate.

Fig. 135 - Idiogram.

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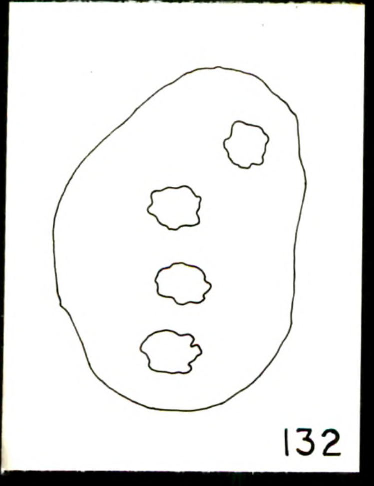
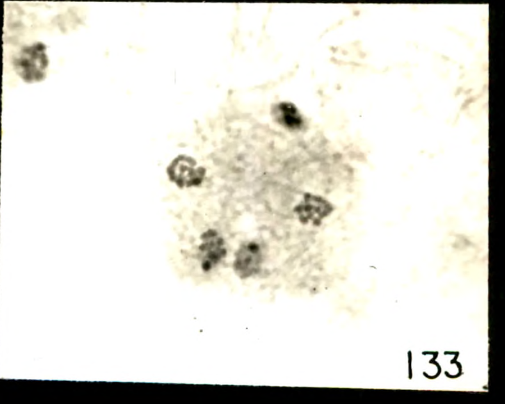


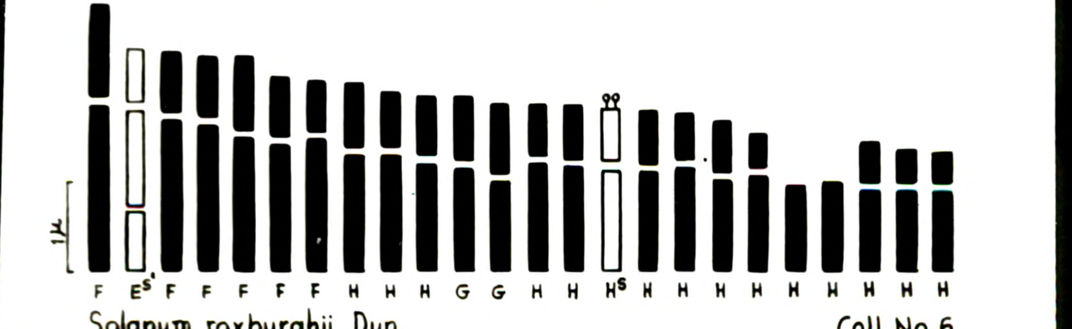
132



133

Solanum roxburghii Dun. Coll. No. 6

134



Solanum roxburghii Dun. Coll. No. 6

135

PL. 2 : 29

Pl. 2:30

Solanum roxburghii

Coll. No. 6:

(Mitosis)

Fig. 136 - Photomicrograph of the somatic metaphase plate.

Coll. No. 18 :

(Mitosis)

Fig. 137 - Camera lucida drawing of somatic metaphase plate.

Fig. 138 - Idiogram.

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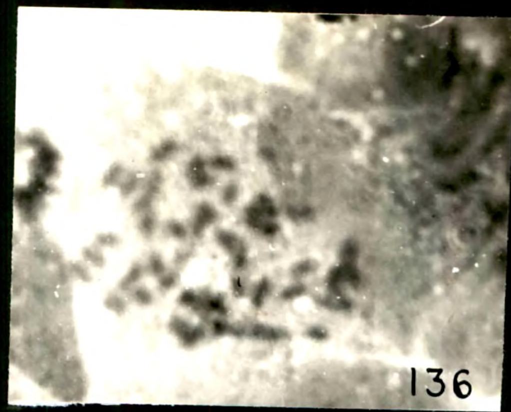
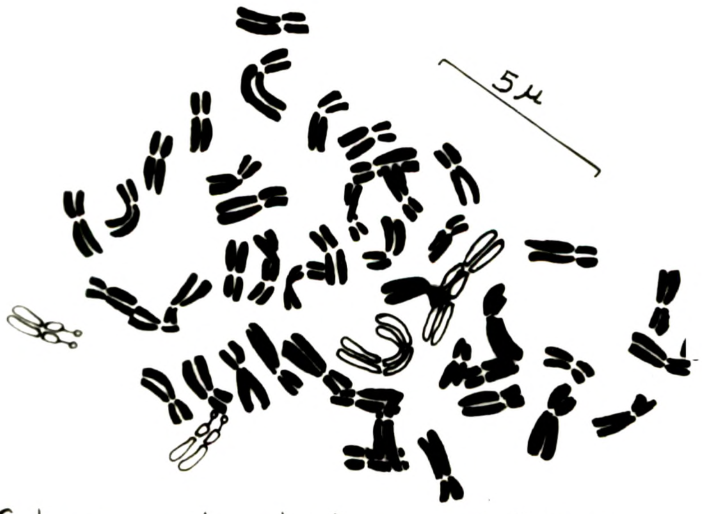


136



Solanum roxburghii Dun. Coll. No. 18

137

Solanum roxburghii Dunal COLL. NO. 18

138

PL. 2 : 30

Table 2:20. Details of the karyotype analysis of <u>Solanum roxburghii</u> Dun. (Coll. No. 18).

Chromosome pair	Length in μ: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.141 + 0.664	+	1.183	=	2.988	0.65	1.52	100	nm	$D^{S'}$
3, 4	1.909	+	0.830	=	2.739	0.43	2.30	91	nsm	F
5, 6	1.390	+	0.581	=	1.971	0.41	2.39	66	nsm	H
7, 8	1.286	+	0.622	=	1.909	0.48	2.06	63	nsm	H
9,10	1.349	+	0.560	=	1.909	0.41	2.41	63	nsm	H
11,12	1.203	+	0.705	=	1.909	0.59	1.71	63	nsm	H
13,14	1.203	+	0.623	=	1.826	0.51	1.93	61	nsm	H
15,16	1.120	+	0.664	=	1.784	0.59	1.69	59	nsm	H
17,18	1.120	+	0.623	=	1.743	0.55	1.80	58	nsm	H
19,20	1.203	+	0.519	=	1.722	0.43	2.32	57	nsm	H
21,22	1.120	+	0.581	=	1.701	0.52	1.93	56	nsm	H
23,24	1.037	+	0.664	=	1.701	0.64	1.56	56	nm	G
25,26	1.079	+	0.622	=	1.701	0.58	1.73	56	nsm	H
27,28	1.120	+	0.560	=	1.680	0.50	2.00	56	nsm	H
29,30	1.017	+	0.581	=	1.598	0.57	1.75	53	nsm	H
31,32	0.913	+	0.685	=	1.598	0.75	1.33	53	nm	G
33,34	1.017	+	0.581	=	1.598	0.57	1.75	53	nsm	H
35,36	1.037	+	0.457	=	1.494	0.44	0.96	50	nsm	H
37,38	0.934	+	0.539	=	1.473	0.58	1.73	49	nsm	H
39,40	0.913	+	0.518	=	1.431	0.56	1.76	47	nsm	H
41,42	0.788	+	0.622	=	1.411	0.78	1.27	47	nm	G
43,44	0.893	+	0.456	=	1.349	0.51	1.96	45	nsm	H^S
45,46	0.810	+	0.539	=	1.349	0.66	1.50	45	nm	G
47,48	0.747	+	0.436	=	1.183	0.58	1.71	39	nsm	H
	27.015		14.752		41.767					

L/S = 2.52

Mean length = 0.87 μ

T F % = 35.32%

Karyotype formula = $2n = 48 = D_2^{S'} + F_2 + G_8 + H_2^S + H_{34}$

Table 2:21. Comparison of the somatic chromosomes of different populations of *Solanum roxburghii* Dunal

Populations	Somatic number (2n)	n m Types		S M Type	n s m Types		Chromosome with secondary constriction Types		Chromosome with satellite Type	Absolute length in μ	Mean length in μ	L/S
		D	G	E	F	H	$D^{S'}$	$E^{S'}$	H^{S}			
Coll.No.06	48	-	4	2	12	30	-	2	2	43.459	0.91	2.43
Coll.No.18	48	2	8	-	2	36	2	-	2	41.767	0.87	2.52

The presence of cytotype within the species is not emphasised because of the close morphological resemblance and very few structural differences observed in the karyotypes of these populations.

8\21

During meiosis at early and late diakinesis (Figs. 140, 141 and 154) and metaphase I (Figs. 142, 143 and 155) 24 bivalents are seen. In majority of the PMCs equal distribution of chromosome is observed at telophase I (Fig. 157). During second meiotic division at metaphase II, anaphase II and telophase II (Figs. 158, 159) regular and synchronised behaviour of chromosomes is observed. However, in few PMCs presence of non congressional bivalents at metaphase I (Figs. 142, 144, & 145) are observed. In some pollen mother cells, lagging of chromosomes at anaphase I (Fig. 152), stickiness of bivalents (Fig. 153) and laggards at telophase I (Fig. 148) are noticed. Moreover, observed abnormalities such as, non synchronised movement of chromosomes of two metaphase plates (Fig. 150) and presence of laggards at telophase II (Fig. 151) are worth mentioning. In quite a few PMCs, early and late disjunct bivalents at metaphase I (Figs. 146, 147 and 156) and abnormal orientation of metaphase II (Fig. 149) plates, are recorded. But these abnormalities are present in very low percentage of pollen mother cells so it does not affect pollen fertility which is as high as 92%.

Pl. 2:31

Solanum roxburghii

Coll. No. 18 :

(Mitosis)

Fig. 139 - Photomicrograph of the somatic metaphase plate.

Coll. No. 6 :

(Meiosis)

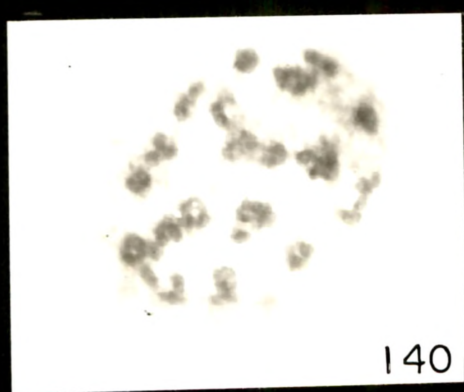
Fig. 140 - PMC showing 24 bivalents at diakinesis.

Fig. 142 - " " metaphase I (side view) with few non congressional bivalents.

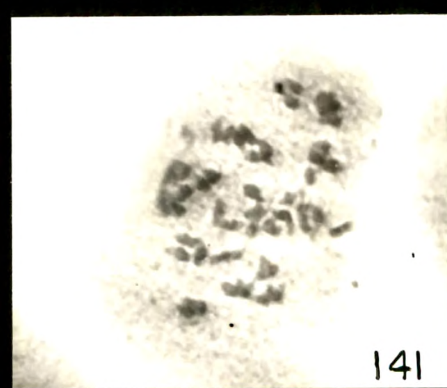
Fig. 141 - " " separating bivalents at metaphase I (Polar view).

Fig. 143 -

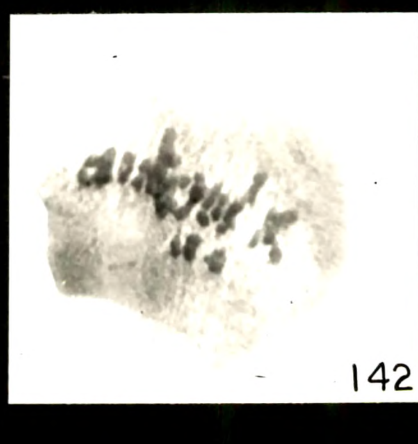
139



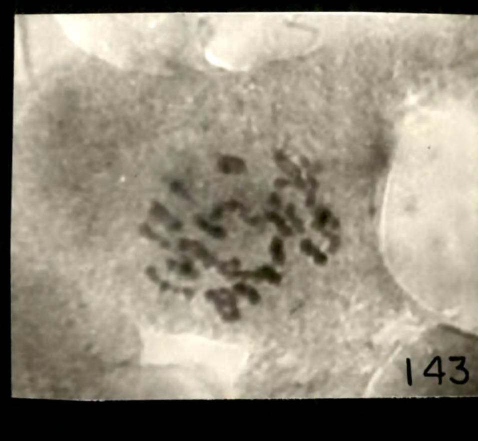
140



141



142



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PL. 2 : 31

Pl. 2:32

Solanum roxburghii

Coll. No. 6:

(Meiosis)

Fig. 144 -	PMC	showing	non congressional bivalents at metaphase I.
Figs. 145, 146 and 147 -	"	"	early separation of few bivalents at metaphase I.
Fig. 148 -	"	"	laggard at telophase I.
Fig. 149 -	"	"	abnormal orientation of metaphase plates.

Coll.No.22 :

Fig. 150 -	"	"	non synchronised movements of chromosomes at two poles.
Fig. 151 -	"	"	laggards at telophase II.

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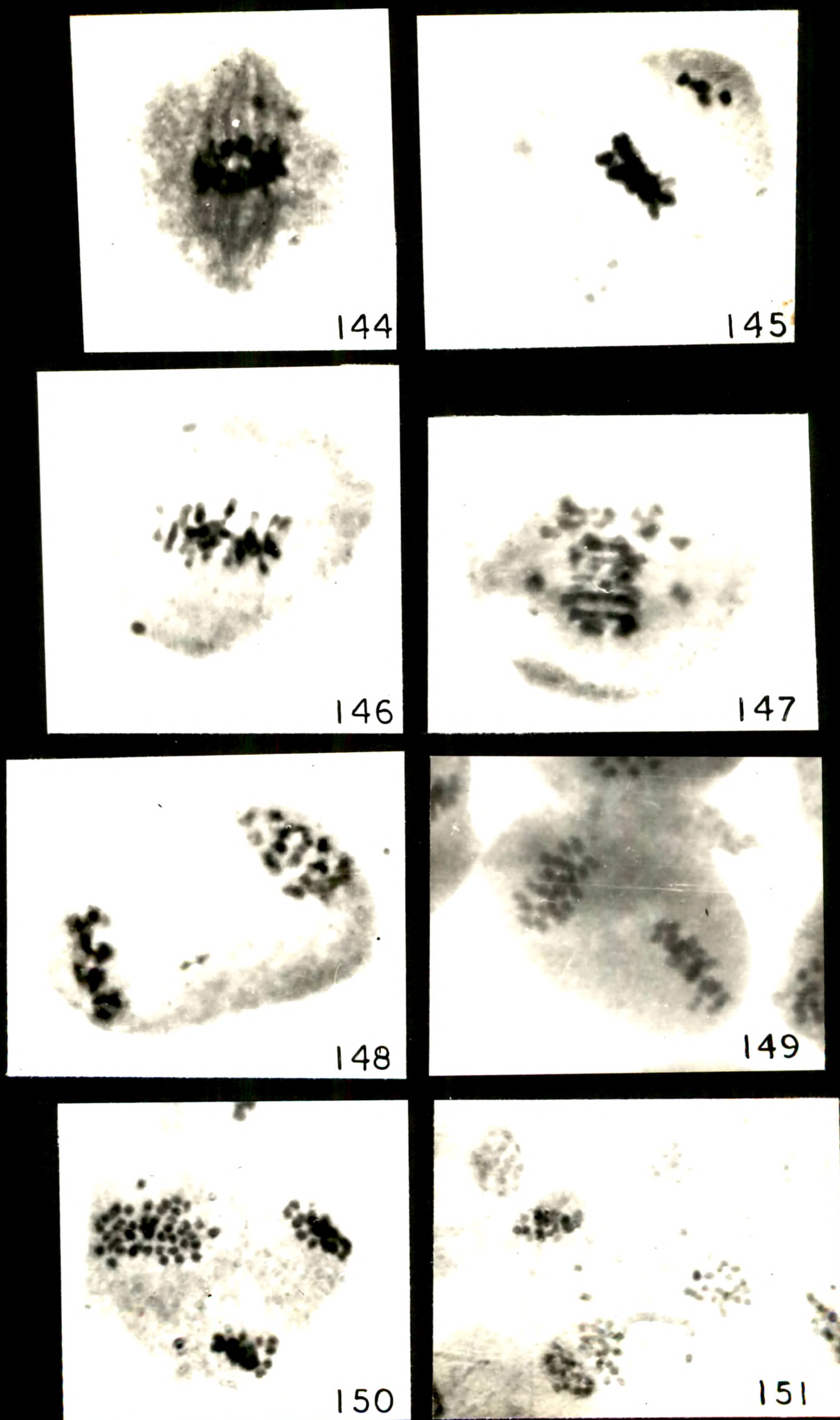


PL. 2:32

Pl. 2:33

Solanum roxburghii

Coll. No. 3 :

(Meiosis)

Fig. 152 - PMC showing lagging bivalents at anaphase I.

Fig. 153 - " " stickiness of the chromosomes at anaphase I.

Coll. No. 18 :

Fig. 154 - " " 24 bivalents at late diakinesis.

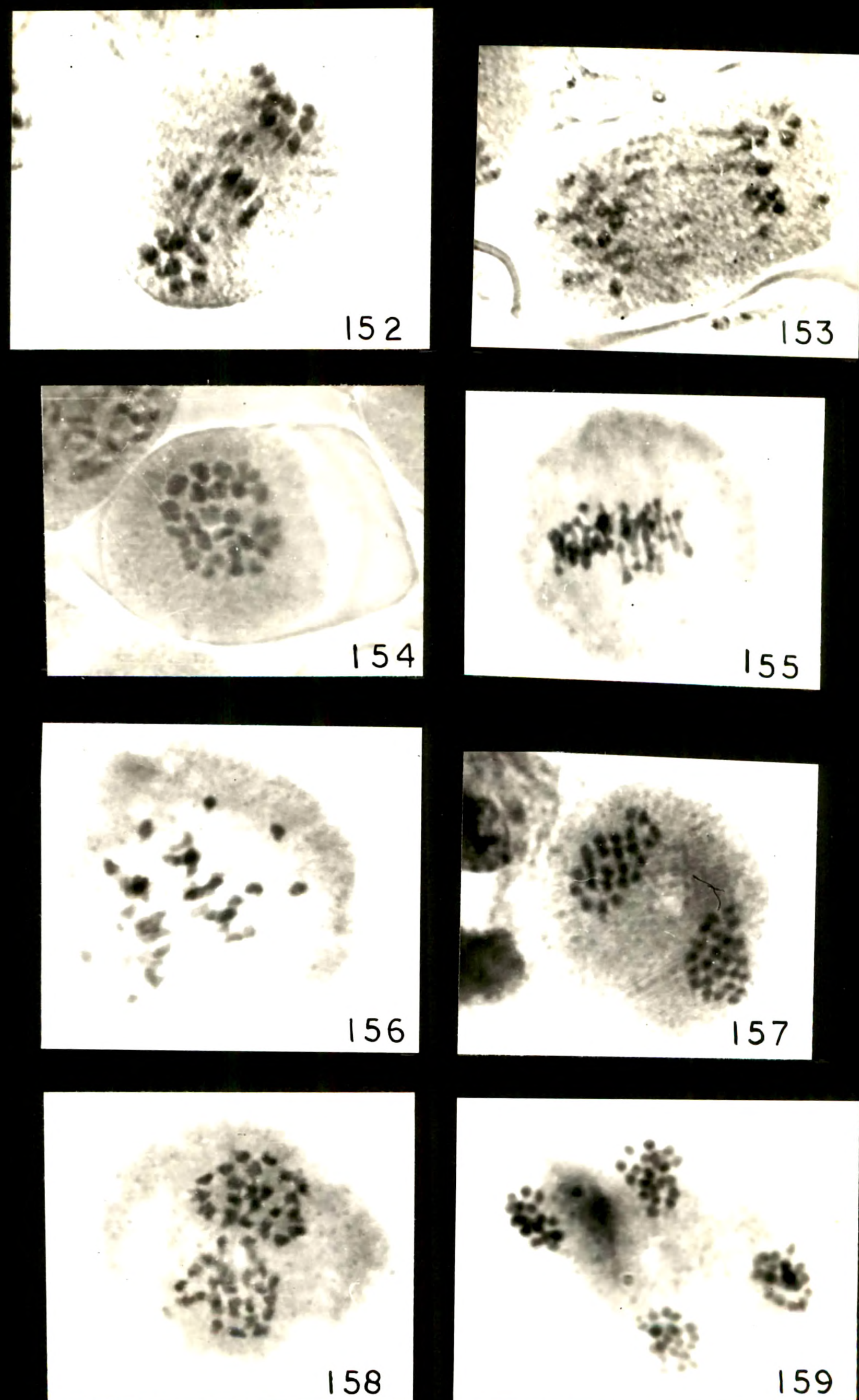
Fig. 155 - " " " " " " metaphase I.

Fig. 156 - " " early and late disjunct bivalents at metaphase I.

Fig. 157 - " " equal distribution of chromosomes at telophase I.

Fig. 158 - " " metaphase II (Polar view).

Fig. 159 - " " normal distribution at telophase II.



PL. 2:33

<u>*Solanum purpureilineatum*</u> Sabnis & Bhatt

The somatic chromosome number for the species is reported by Bhatt (1974) as 2n = 48. Same number is confirmed by the present investigation of the populations.

<u>Coll. Nos. 11, 46, 47</u> :

Karyotype formulae :

(Coll. No. 11) $2n = 48+ 3B = D_2+F_2^{S'}+F_2^{S}+F_{12}+G_8+H_{22}$

(Table 2:22)

(Coll. No. 46) $2n = 48 = D_6+F_2^{S'}+F_{18}+G_6+H_2^{S}+H_{14}$

(Table 2:23)

(Coll. No. 47) $2n = 48+ 2B = D_2+F_2^{S}+F_{14}+G_{14}+H_2^{S'}+H_{14}$

(Table 2:24)

All the populations show the presence of medium to short sized chromosomes in their complements. Moreover, they also show common features such as, more number of chromosome pairs having nearly submedian centromeres (F & H-types), presence of a pair of secondarily constricted chromosome and a pair of satellited chromosomes. However, these populations show marginal differences in values of absolute length, mean length and L/S ratio (Table 2:25). Of the analysed populations coll. Nos. 47 & 11 reveal the presence of 2 and 3 accessory chromosomes (B-chromosome) respectively. In contrast to this,

Table 2:22. Details of the karyotype analysis of Solanum purpureilineatum Sabnis & Bhatt (Coll. No. 11).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.826	+ 0.954	= 2.780	0.52	1.91	100	nsm	F
3, 4	1.515	+ 0.871	= 2.386	0.57	1.74	85	nsm	F
5, 6	0.664 + 0.830	+ 0.747	= 2.241	0.5	2.0	81	nsm	$F^{S'}$
7, 8	1.556	+ 0.643	= 2.199	0.41	2.41	79	nsm	F
9,10	1.473	+ 0.705	= 2.178	0.48	2.09	78	nsm	F
11,12	1.556	+ 0.581	= 2.137	0.37	2.68	76	nsm	F
13,14	1.494	+ 0.602	= 2.096	0.40	2.48	75	nsm	F^S
15,16	1.432	+ 0.643	= 2.075	0.45	2.22	74	nsm	F
17,18	1.266	+ 0.788	= 2.054	0.62	1.60	73	nm	D
19,20	1.307	+ 0.664	= 1.971	0.51	1.96	70	nsm	H
21,22	1.328	+ 0.602	= 1.930	0.45	2.20	69	nsm	H
23,24	1.183	+ 0.726	= 1.909	0.61	1.62	68	nm	G
25,26	1.349	+ 0.560	= 1.909	0.41	2.41	68	nsm	H
27,28	1.287	+ 0.622	= 1.909	0.48	2.07	68	nsm	H
29,30	1.120	+ 0.747	= 1.867	0.66	1.49	67	nm	G
31,32	1.203	+ 0.552	= 1.755	0.45	2.18	63	nsm	H
33,34	1.100	+ 0.581	= 1.681	0.52	1.89	60	nm	G
35,36	1.100	+ 0.560	= 1.660	0.50	1.96	59	nsm	H
37,38	1.058	+ 0.581	= 1.639	0.55	1.82	58	nsm	H
39,40	1.100	+ 0.477	= 1.577	0.43	2.31	56	nsm	H
41,42	1.120	+ 0.457	= 1.577	0.41	2.45	56	nsm	H
43,44	1.120	+ 0.457	= 1.577	0.41	2.45	56	nsm	H
45,46	0.934	+ 0.602	= 1.536	0.64	1.55	55	nm	G
47,48	0.934	+ 0.477	= 1.411	0.51	1.95	50	nsm	H
	30.855	15.199	46.054					

L/S = 1.97

Mean length = 0.96 μ

T F % = 33%

Karyotype formula = $2n = 48 + 3B = D_2 + F^{S'}_2 + F^S_2 + F_{12} + G_8 + H_{22}$

Pl. 2:34

Solanum purpureilineatum

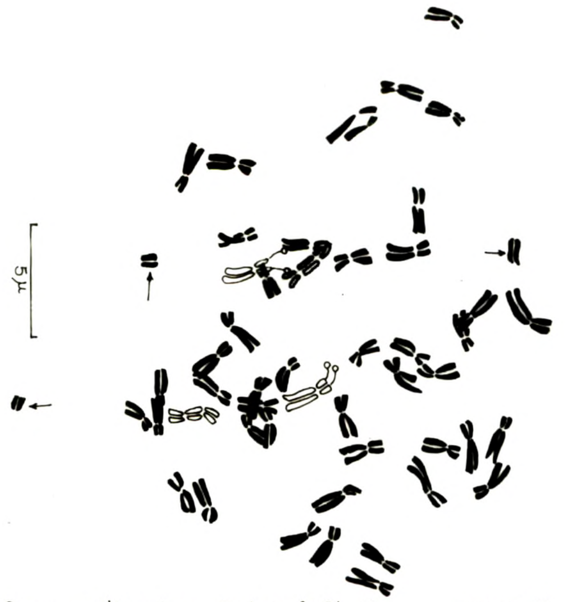
Coll. No. 11 :

(Mitosis)

Fig. 160 - Camera lucida drawing of somatic metaphase plate.

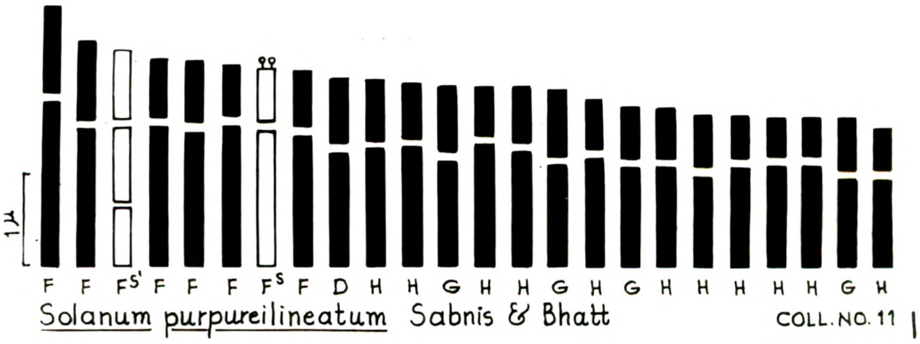
Fig. 161 - Idiogram.

Fig. 162 - Photomicrograph of somatic metaphase plate.

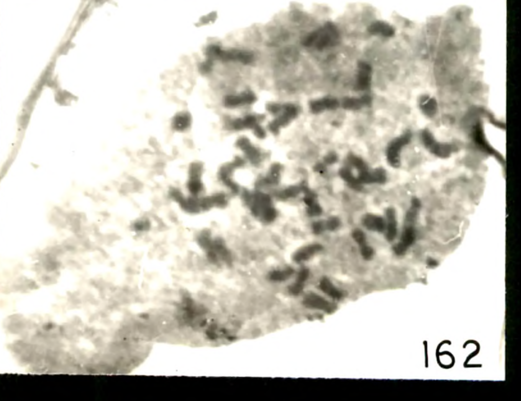


S. purpureilineatum Sabnis & Bhatt COLL. NO. 11

160



Solanum purpureilineatum Sabnis & Bhatt COLL. NO. 11 161



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PL. 2 : 34

Table 2:23. Details of the karyotype analysis of <u>Solanum purpureilineatum</u> Sabnis & Bhatt (Coll. No. 46).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	1.826	+	0.892	=	2.718	0.49	2.05	100	nsm	F
3, 4	1.681	+	0.892	=	2.573	0.53	1.88	94	nsm	F
5, 6	1.577	+	0.913	=	2.490	0.58	1.73	91	nsm	F
7, 8	0.851 + 0.934	+	0.685	=	2.470	0.38	2.60	91	nsm	$F^{S'}$
9,10	1.618	+	0.788	=	2.406	0.49	2.05	88	nsm	F
11,12	1.577	+	0.747	=	2.324	0.47	2.11	85	nsm	F
13,14	1.473	+	0.809	=	2.282	0.55	1.82	84	nsm	F
15,16	1.369	+	0.892	=	2.261	0.65	1.53	83	nm	D
17,18	1.411	+	0.809	=	2.220	0.57	1.74	81	nsm	F
19,20	1.265	+	0.809	=	2.074	0.63	1.56	76	nm	D
21,22	1.369	+	0.685	=	2.054	0.50	2.00	75	nsm	F
23,24	1.245	+	0.788	=	2.034	0.63	1.58	74	nm	D
25,26	1.265	+	0.747	=	2.012	0.59	1.69	74	nsm	F
27,28	1.390	+	0.602	=	1.992	0.43	2.30	73	nsm	H^S
29,30	1.079	+	0.913	=	1.992	0.84	1.18	73	nm	G
31,32	1.203	+	0.747	=	1.950	0.62	1.61	71	nm	G
33,34	1.162	+	0.705	=	1.867	0.60	1.65	68	nsm	H
35,36	1.079	+	0.788	=	1.867	0.73	1.36	68	nm	G
37,38	1.162	+	0.664	=	1.826	0.57	1.75	67	nsm	H
39,40	1.182	+	0.622	=	1.804	0.52	1.78	66	nsm	H
41,42	1.141	+	0.602	=	1.743	0.53	1.89	64	nsm	H
43,44	1.058	+	0.622	=	1.680	0.58	1.70	61	nsm	H
45,46	1.037	+	0.602	=	1.639	0.58	1.72	60	nsm	H
47,48	1.058	+	0.539	=	1.597	0.50	1.96	58	nsm	H
	32.013		17.862		49.875					

L/S = 1.79

Mean length = 1.04 μ

T F % = 35.08%

Karyotype formula = $2n = 48 = D_6 + F_2^{S'} + F_{18} + G_6 + H_2^S + H_{14}$

Pl. 2:35

Solanum purpureilineatum

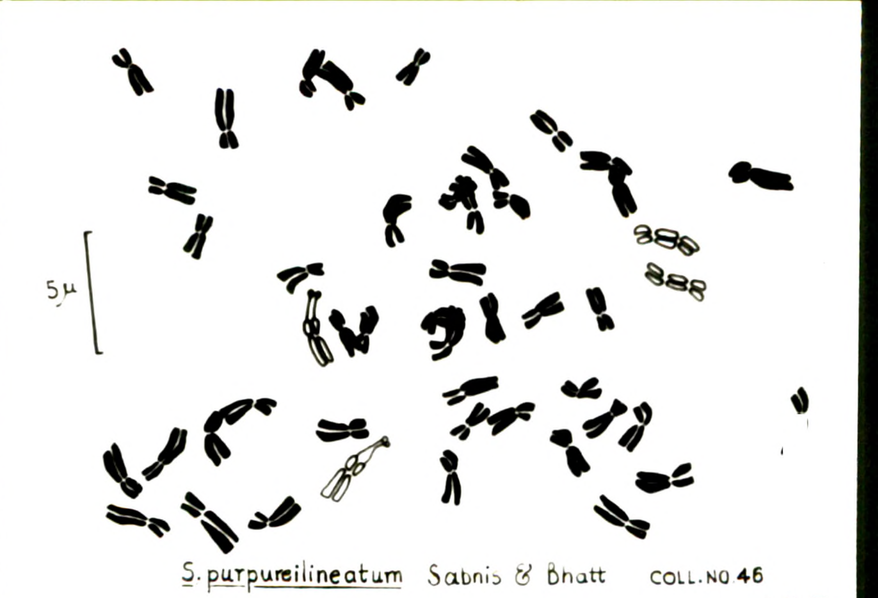
Coll. No. 46 :

(Mitosis)

Fig. 163 - Camera lucida drawing of somatic metaphase plate.

Fig. 164 - Idiogram.

Fig. 165 - Photomicrograph of somatic metaphase plate.



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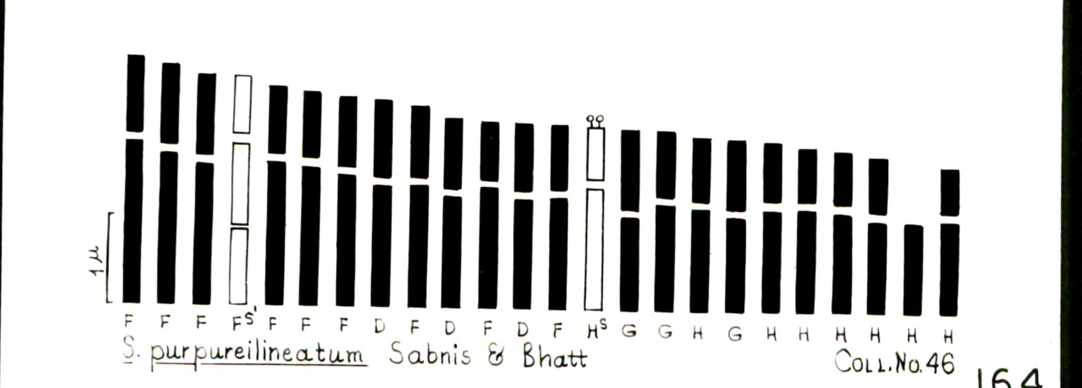
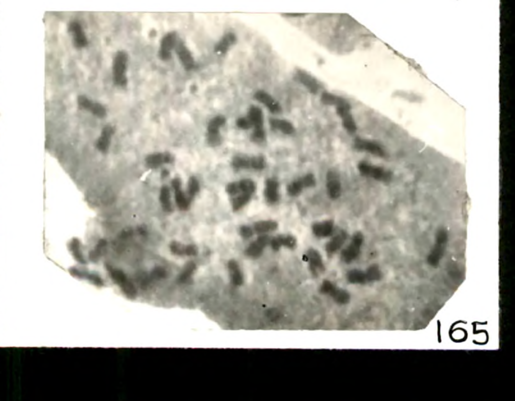


164


165

PL. 2 : 35

Table 2:24. Details of the karyotype analysis of <u>Solanum purpureilineatum</u> Sabnis & Bhatt (Coll. No. 47).

Chromosome pair	Length in µ: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.743	+	0.975	=	2.718	0.56	1.79	100	nsm	F
3, 4	1.681	+	0.892	=	2.573	0.53	1.88	94	nsm	F
5, 6	1.888	+	0.664	=	2.552	0.35	2.84	93	nsm	F^S
7, 8	1.556	+	0.809	=	2.365	0.52	1.92	87	nsm	F
9,10	1.723	+	0.622	=	2.345	0.36	2.77	86	nsm	F
11,12	1.390	+	0.851	=	2.241	0.61	1.63	82	nm	D
13,14	1.577	+	0.622	=	2.199	0.39	2.53	80	nsm	F
15,16	1.535	+	0.664	=	2.199	0.43	2.31	80	nsm	F
17,18	1.494	+	0.581	=	2.075	0.38	2.57	76	nsm	F
19,20	0.581 + 0.726	+	0.685	=	1.992	0.52	1.90	73	nsm	$H^{S'}$
21,22	1.286	+	0.664	=	1.950	0.52	1.93	71	nsm	G
23,24	1.121	+	0.788	=	1.909	0.70	1.42	70	nm	H
25,26	1.100	+	0.809	=	1.909	0.73	1.35	70	nm	H
27,28	1.183	+	0.705	=	1.888	0.59	1.67	69	nsm	H
29,30	1.183	+	0.685	=	1.868	0.57	1.72	68	nsm	H
31,32	1.183	+	0.685	=	1.868	0.57	1.72	68	nsm	H
33,34	1.120	+	0.747	=	1.867	0.66	1.49	68	nm	G
35,36	1.120	+	0.747	=	1.867	0.66	1.49	68	nm	G
37,38	0.975	+	0.685	=	1.660	0.70	1.42	61	nm	G
39,40	0.892	+	0.726	=	1.618	0.81	1.23	59	nm	G
41,42	0.975	+	0.622	=	1.597	0.63	1.56	58	nm	G
43,44	0.975	+	0.539	=	1.514	0.55	1.80	55	nsm	H
45,46	0.954	+	0.457	=	1.411	0.47	2.08	51	nsm	H
47,48	0.789	+	0.539	=	1.328	0.68	1.46	48	nm	G
	30.750		16.763		47.513					

L/S = 2.04

Mean length = 0.98 µ

T F % = 35.28%

Karyotype formula = 2n = 48+ 2B = $D_2 + F_2^S + F_{14} + G_{14} + H_2^{S'} + H_{14}$

Pl. 2:36

Solanum purpureilineatum

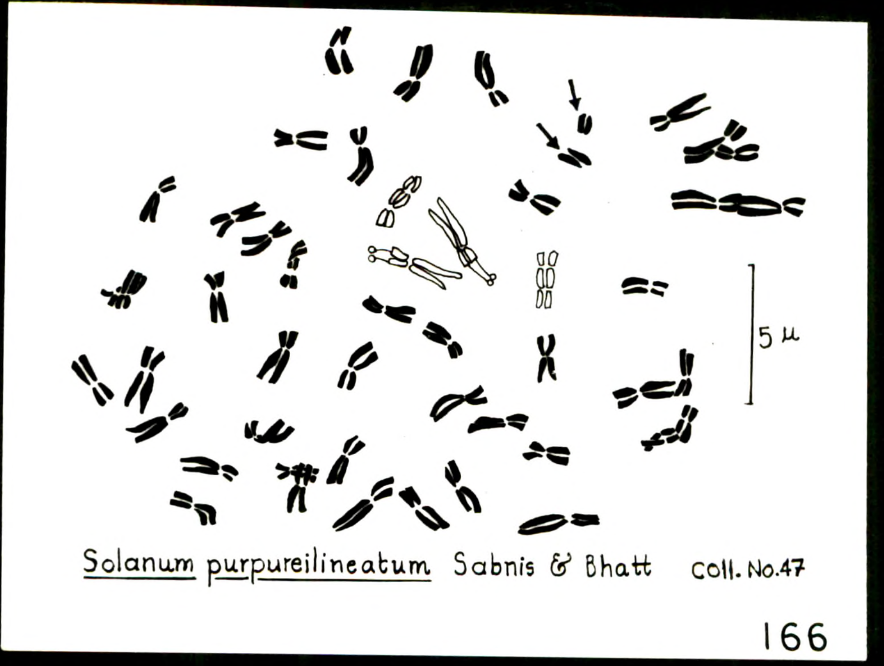
Coll. No. 47 :

(Mitosis)

Fig. 166 - Camera lucida drawing of somatic metaphase plate.

Fig. 167 - Idiogram.

Fig. 168 - Photomicrograph of somatic metaphase plate.



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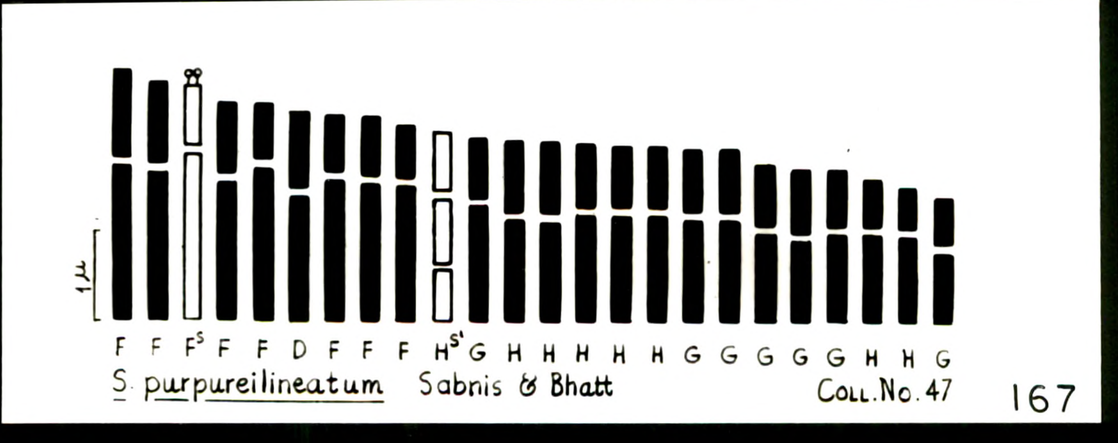

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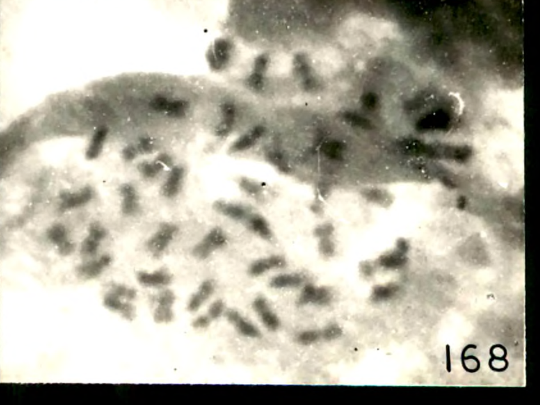


168

PL. 2 : 36

Table 2:25. Comparison of somatic chromosomes of different populations of *Solanum purpureilineatum* Sabnis & Bhatt

Populations	Somatic number (2n)	n m Types		n s m Types		Chromosome with secondary constriction Types		Chromosome with satellite Types		Absolute length in μ	Mean length in μ	L/S
		D	G	F	H	$F^{S'}$	$H^{S'}$	F^{S}	H^{S}			
Coll.No.11	48+3B	2	8	16	22	2	-	2	-	46.054	0.96	1.97
Coll.No.46	48	6	6	20	16	2	-	-	2	49.875	1.04	1.79
Coll.No.47	48+2B	2	14	16	16	-	2	2	-	47.513	0.98	2.04

coll. No. 46 did not show presence of B-chromosomes within its karyotype. The calculated values of TF% are 33.00% for Coll. No. 11, 35.08% for Coll. No. 46 and 35.28% for coll. No. 47. These values and idiograms depict the asymmetrical nature of the karyotypes. Moreover, values of relative length for these populations tend to indicate the smooth gradation of the same (Figs. 160-162, 163-165, 166-168).

The present analysis tallies with the earlier analysis of Bhatt (1974) as regards the size of chromosomes and in having one pair of satellited chromosomes. However, in the present study all the 3 populations showed the presence of a pair of secondarily constricted chromosomes in addition to the satellited one. Occurrence of B-chromosomes, observed in 2 populations, have not been reported by the earlier worker.

On the whole meiosis is more or less regular in this species. 24 bivalent are noticed at early and late diakinesis (Figs. 169 & 170). In subsequent stages, normal behaviour of the meiotic chromosomes is observed in most of the PMCs (Fig. 174). However, in very few pollen mother cells, groupings of bivalents at late diakinesis (Fig. 171) early separation of few bivalents at metaphase and anaphase I (Figs. 172 & 173) and groupings of bivalents at metaphase I (Fig. 175) are noticed. The determined pollen fertility for the species is 93.75%.

Pl. 2:37

S. purpureilineatum

Coll. No. 46 :

(Meiosis)

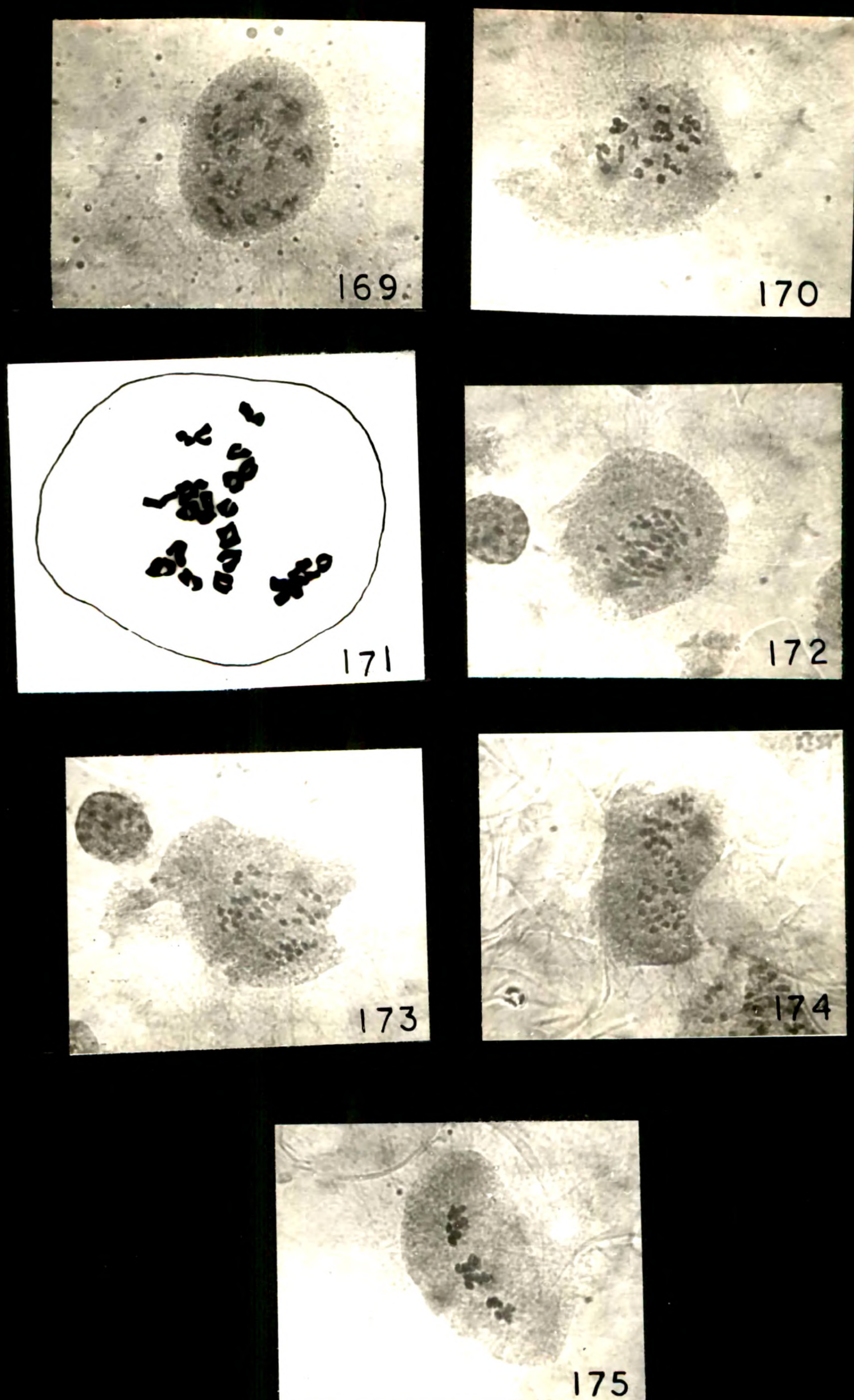
Fig. 169 - Fig. 170 PMC showing 24 bivalents at early and late diakinesis.

Fig. 171 - " " groupings of bivalents at late diakinesis.

Fig. 172 - Fig. 173 " " separating bivalents at metaphase and anaphase I.

Fig. 174 - " " duplicating chromosomes at metaphase II (Polar view).

Fig. 175 - " " groupings of bivalents at metaphase I.



PL. 2 : 37

Solanum nodiflorum Jacq.

Solanum nodiflorum has been studied in the past by a number of researchers. Heiser & Whitakar (1948), Westergaard (1948), Stebbins & Paddock (1949), Mulligan (1961), Venkateswarlu & Bhiravamurthy (1962) have reported 2n = 24. In contrast to this, Baylis (1958) has reported 2n = 72. Both the diploid and hexaploid populations of the species reported by earlier workers have been used for hybridization with S. americanum (Soria & Heiser, 1961), S. villosum (Westergaard, 1948) and S. nigrum (Rao, Khan & Khan, 1978) to ascertain the genome relationship and to understand the course of speciation followed by allied species.

Coll. No. 26 :

Karyotype formula : $2n = 24 = D_2 + F_2^S + F_{16} + H_4$

(Table 2:26)

Within the somatic complement of 24 chromosomes only 2 are with nearly median centromeres (D-type) and the remaining 22 are with nearly submedian centromeres (F & H-types). Among these, a chromosome pair of F^S-type has satellites. The longest chromosome of the complement is 2.822 µ and the shortest is 1.286 µ in length. The calculated value of the mean length is 1.19 µ. The asymmetrical and the evolved nature is noticed in the

Table 2.26. Details of the karyotype analysis of _Solanum nodiflorum_ Jacq. (Coll. No. 26).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.909	+ 0.913	= 2.822	0.48	2.09	100	nsm	F
3, 4	1.992	+ 0.768	= 2.760	0.38	2.59	97	nsm	F
5, 6	1.867	+ 0.871	= 2.739	0.46	2.14	97	nsm	F
7, 8	1.764	+ 0.809	= 2.573	0.45	2.18	91	nsm	F
9,10	1.618	+ 0.913	= 2.531	0.56	1.77	89	nsm	F
11,12	1.784	+ 0.747	= 2.531	0.41	2.38	89	nsm	F^S
13,14	1.701	+ 0.809	= 2.510	0.47	2.10	88	nsm	F
15,16	1.660	+ 0.705	= 2.365	0.42	2.35	84	nsm	F
17,18	1.390	+ 0.871	= 2.261	0.62	1.59	80	nm	D
19,20	1.535	+ 0.706	= 2.241	0.45	2.17	79	nsm	F
21,22	1.286	+ 0.643	= 1.929	0.50	2.00	68	nsm	H
23,24	0.871	+ 0.415	= 1.286	0.47	2.09	45	nsm	H
	19.378	9.170	28.548					

L/S = 2.19

Mean length = 1.19 μ

T F % = 32.12%

Karyotype formula = 2n = 24 = $D_2 + F_2^S + F_{16} + H_4$

idiogram and the same is substantiated by calculated TF% i.e. 32.12% and L/S ratio i.e. 2.19. The idiogram also depict smooth gradation except at the end (Figs. 176, 177 & 178).

Coll. No. 27 :

Karyotype formula : $2n = 24 = D_2+F_2^{S'}+F_8+H_{12}$

(Table 2:27)

The karyotype of this collection resembles the previous one in its having same number of chromosomes with nearly median and nearly submedian centromeres. The types of chromosomes, present in this complement also belong to D, F & H-types. In contrast to the previous collection L/S ratio is much less i.e. 1.76 and instead of a satellited pair, the complement contains a pair of secondarily constricted ($F^{S'}$-type) chromosomes. But for the above mentioned differences, the idiograms of the two populations tally with each other as regard the asymmetry and graded nature of the karyotype (Fig. 179, 180, 181).

Coll. No. 28 :

Karyotype formula : $2n = 24 = D_2+F_{10}+G_4+H_2^S+H_6$

(Table 2:28)

In contrast to previous two populations, the somatic

Pl. 2: 38

Solanum nodiflorum

Coll. No. 26 :

(Mitosis)

Fig. 176 - Camera lucida drawing of somatic metaphase plate.

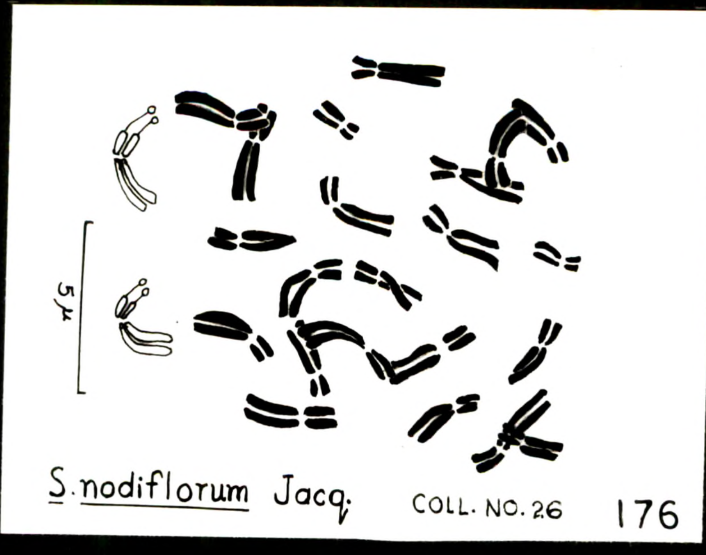
Fig. 177 - Idiogram.

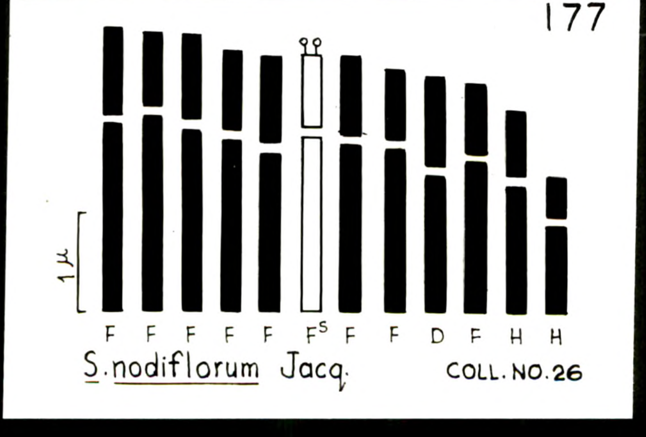
Fig. 178 - Photomicrograph of somatic metaphase plate.

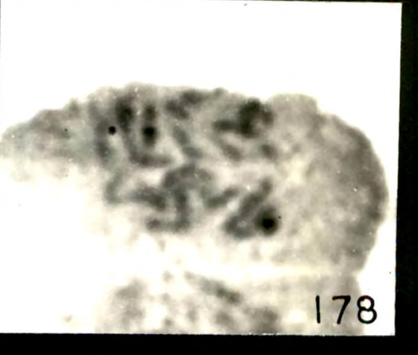
Coll. No. 27 :

Fig. 179 - Camera lucida drawing of somatic metaphase plate.

Contd...


5 μ
S. nodiflorum Jacq.
COLL. NO. 26
176


177
1 μ
F F F F F F^{S} F F D F H H
S. nodiflorum Jacq.
COLL. NO. 26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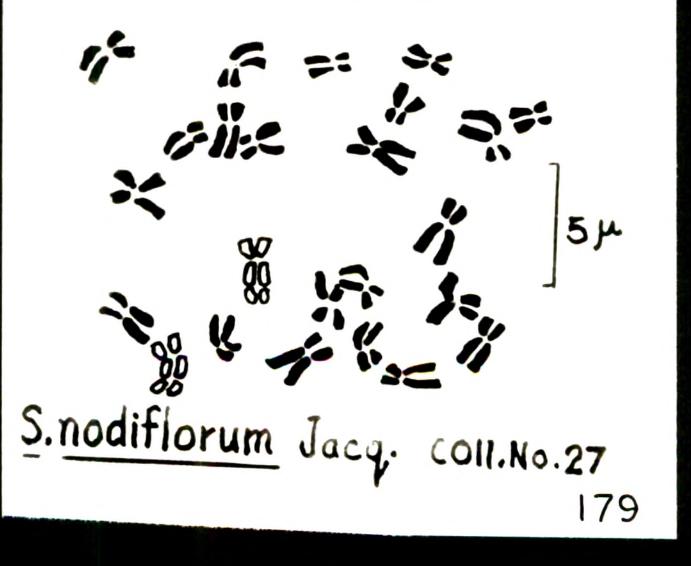

5 μ
S. nodiflorum Jacq.
COll. No. 27
179

PL. 2 : 38

Pl. 2:39

Solanum nodiflorum

Coll. No. 27 (Contd.)

(Mitosis)

Fig. 180 - Idiogram.

Fig. 181 - Photomicrograph of somatic metaphase plate.

Coll. No. 28 :

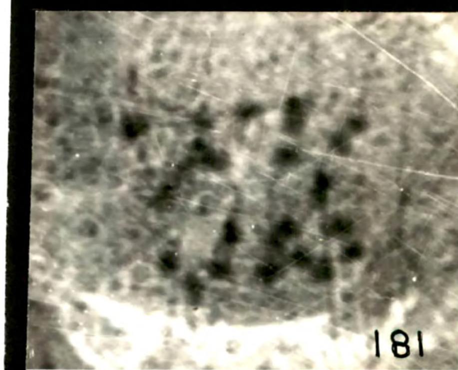
Fig. 182 - Camera lucida drawing of somatic metaphase plate.

Fig. 183 - Idiogram.

Fig. 184 - Photomicrograph of the somatic metaphase plate.

Contd...

180



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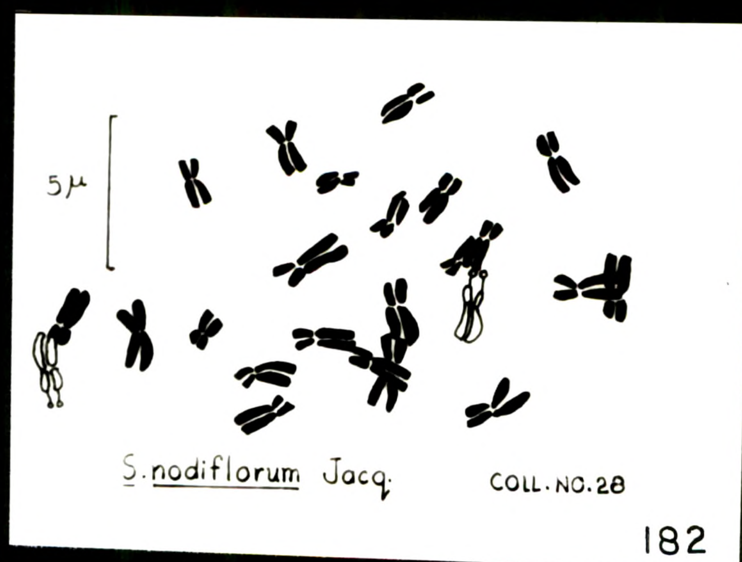

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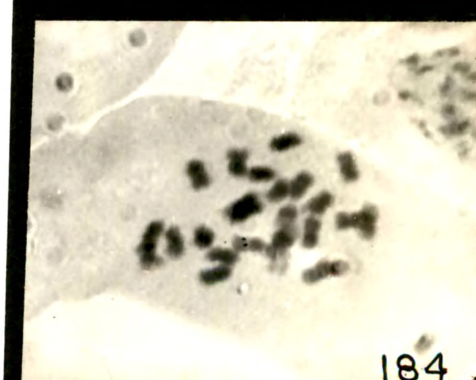

184

PL. 2 : 39

Table 2.27. Details of the karyotype analysis of Solanum nodiflorum Jacq. (Coll. No. 27).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_1	Relative length	Centromere	Type
1, 2	1.666	+	0.721	=	2.387	0.43	2.31	100	nsm	F
3, 4	1.441	+	0.765	=	2.206	0.53	1.88	92	nsm	F
5, 6	1.441	+	0.765	=	2.206	0.53	1.88	92	nsm	F
7, 8	1.306	+	0.856	=	2.162	0.65	1.52	90	nm	D
9,10	1.396	+	0.675	=	2.071	0.48	2.06	86	nsm	F
11,12	0.540 +0.856	+	0.630	=	2.026	0.45	2.21	84	nsm	$F^{S'}$
13,14	1.261	+	0.721	=	1.982	0.57	1.74	83	nsm	H
15,16	1.261	+	0.721	=	1.982	0.57	1.74	83	nsm	H
17,18	1.216	+	0.630	=	1.846	0.51	1.93	77	nsm	H
19,20	1.216	+	0.630	=	1.846	0.51	1.93	77	nsm	H
21,22	0.991	+	0.540	=	1.531	0.54	1.83	64	nsm	H
23,24	0.901	+	0.450	=	1.351	0.50	2.0	56	nsm	H
	15.492		8.104		23.596					

L/S = 1.76

Mean length = 0.98 μ

T F % = 34.34 %

Karyotype formula = $2n = 24 = D_2 + F_2^{S'} + F_8 + H_{12}$

Table 2.28. Details of the karyotype analysis of <u>Solanum nodiflorum</u> Jacq. (Coll. No. 28).

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm +	Short Arm =	Total length	R_1	R_2			
1, 2	1.743 +	0.871 =	2.614	0.50	2.0	100	nsm	F
3, 4	1.494 +	0.788 =	2.282	0.52	1.89	87	nsm	F
5, 6	1.494 +	0.788 =	2.282	0.52	1.89	87	nsm	F
7, 8	1.411 +	0.747 =	2.158	0.53	1.88	82	nsm	F
9,10	1.361 +	0.747 =	2.108	0.55	1.82	80	nsm	F
11,12	1.266 +	0.801 =	2.067	0.63	1.58	79	nm	D
13,14	1.245 +	0.747 =	1.992	0.60	1.66	76	nsm	H^S
15,16	1.120 +	0.747 =	1.867	0.66	1.49	71	nm	G
17,18	1.183 +	0.664 =	1.847	0.56	1.78	70	nsm	H
19,20	1.203 +	0.623 =	1.826	0.51	1.93	69	nsm	H
21,22	1.079 +	0.539 =	1.618	0.50	2.00	61	nsm	H
23,24	0.913 +	0.664 =	1.577	0.72	1.37	60	nm	G
	15.512	8.726	24.238					

L/S = 1.65

Mean length = 1.01 μ

T F % = 36.00 %

Karyotype formula = $2n = 24 = D_2 + F_{10} + G_4 + H_2^S + H_6$

complement of this is having 4 types of chromosomes. Of which G-type present therein is not observed in the other two. Moreover, it contains 3 pairs (D & G-types) with nearly median and remaining 9 pairs (F & H-types) with nearly submedian centromeres. Like coll. No. 26, the karyotype of this also has a pair of satellited chromosome (H^S-type). Like the other 2 populations karyotype of this is also asymmetrical and evolved showing more or less smooth gradation of the idiogram (Figs. 182, 183, 184).

Of the 3 collections, 26 and 28 resemble each other in morphological features. Coll. No. 27 shows little differed morphology. But all the 3 populations are diploid forms showing overall resemblance in their karyotypes (Table 2:29) having only a few structural differences.

Meiosis is quite normal. Presence of 12 distinct bivalents at early and late diakinesis (Figs. 185, 186, 187, 188, 196 & 201) and metaphase I (Fig. 189) are observed. Equal segregation of chromosomes at both poles at metaphase II (Figs. 190, 191 & 192) and in subsequent stages till telophase II (Fig. 202) is observed in majority of the PMCs. In few pollen mother cells, presence of nucleolus at late diakinesis with one or two bivalents nearer to it (Figs. 185, 187, 197, 198 & 199) is marked. However, groupings of bivalents (Figs. 186, 193 & 199), interbivalent connections (185, 187 & 188) at late diakinesis, non synchronised

Table 2:29. Comparison of the somatic chromosomes of the different populations of <u>Solanum nodiflorum</u> Jacq.

Populations	Somatic number (2n)	n m		n s m		Secondary constrictions on long arms	Chromosomes with satellite		Absolute length in μ	Mean length in μ	L/S
		Types		Types							
		D	G	F	H	$F^{S'}$	F^S	H^S			
26	24	2	-	18	4	-	2	-	28.548	1.19	2.19
27	24	2	-	10	12	2	-	-	23.956	0.98	1.76
28	24	2	4	10	8	-	-	2	24.238	1.01	1.65

Pl. 2:40

Solanum nodiflorum

Coll. No. 26 :

(Meiosis)

Fig. 185 -	PMC	showing	diakinesis with 12 distinct bivalents and a few inter bivalent connections.
Fig. 186 -	"	"	grouping of bivalents at late diakinesis.
Fig. 187 and - 188	PMCs	"	a few interbivalent connections and presence of nucleolus at late diakinesis.
Fig. 189 -	PMC	"	metaphase I (Side view).
Fig. 190	"	"	equal distribution of chromosomes at metaphase II (Polar view).
Fig. 191 and - 192	PMCs	"	abnormal orientation of metaphase plates.

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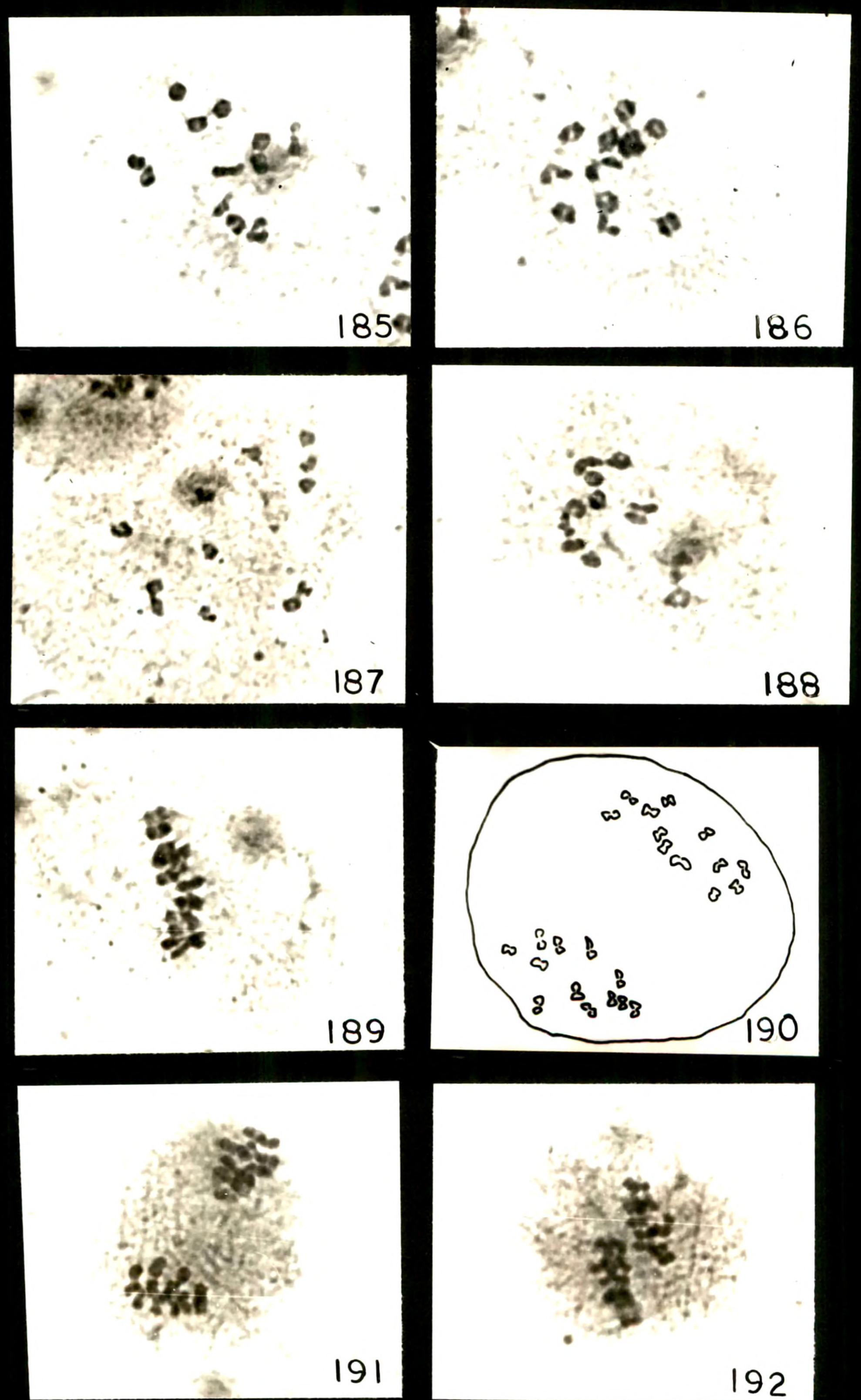

PL. 2 : 40

Pl. 2:41

Solanum nodiflorum

Coll. No. 26 :

(Meiosis)

Fig. 193 -	PMC	showing	secondary grouping of bivalents forming 2 distinct groups.
Figs. 194 and - 195	PMCs	"	non synchronised movement resulting into unequal distribution of chromosomes during 2nd meiotic division.

Coll. No. 27 :

Fig. 196 -	PMC	"	12 distinct bivalents at diakinesis.
Fig. 197 -	"	"	12 distinct bivalents and nucleolus at diakinesis.
Fig. 198 -	"	"	nucleolus along with attached bivalent at diakinesis.

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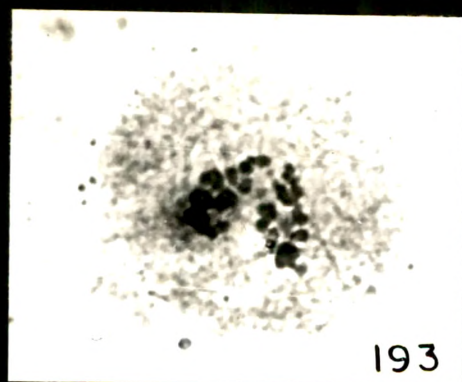

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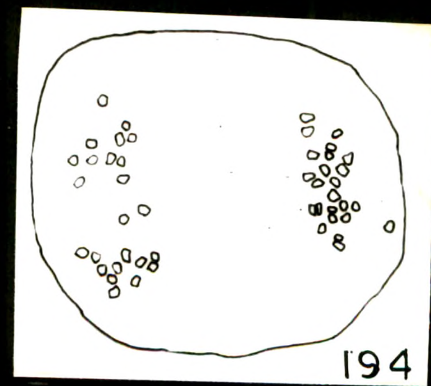

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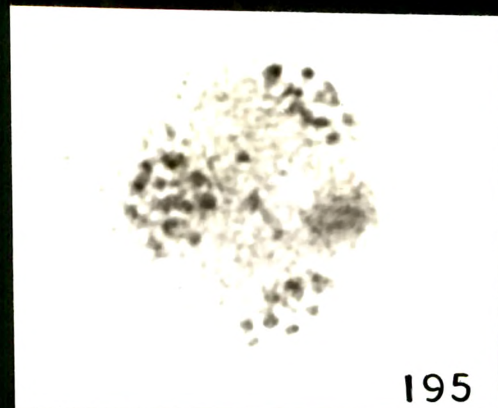

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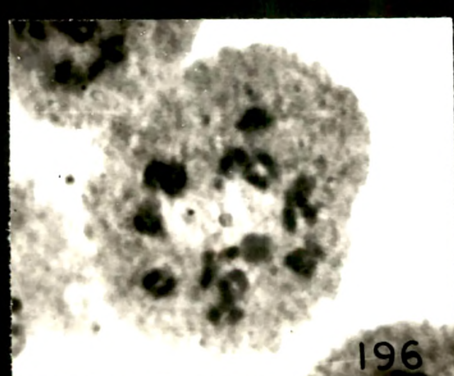

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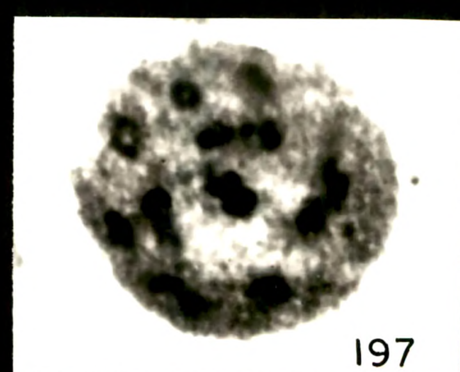


197

198

PL. 2 : 41

Pl. 2:42

Solanum nodiflorum

Coll. No. 27 :

(Meiosis)

Fig. 199 - PMC showing diakinesis. Note groupings of bivalents.

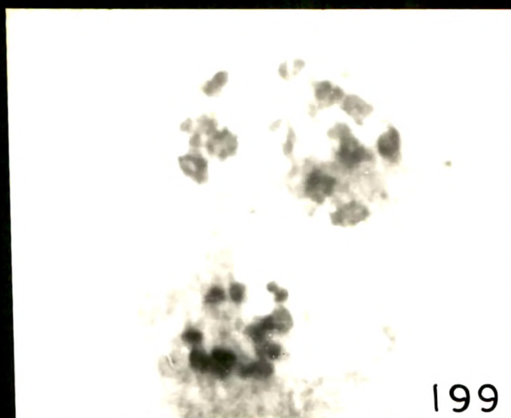
Fig. 200 - " " abnormal orientation, non synchronised movement and lagging chromosomes during 2nd meiotic division.

Coll.No. 28:

Fig. 201 - " " 12 bivalents at early diakinesis.

Fig. 202 - " " unequal distribution of chromosomes at telophase II.

Fig. 203 - " " obliquely linear tetrad formation.



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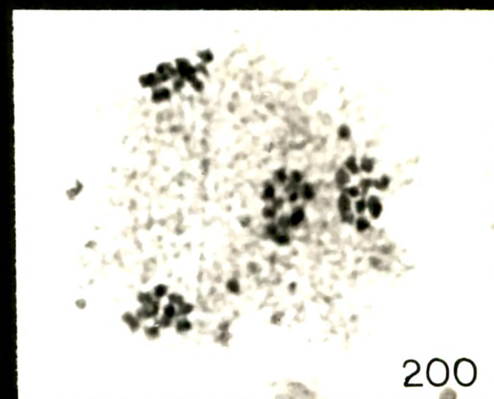
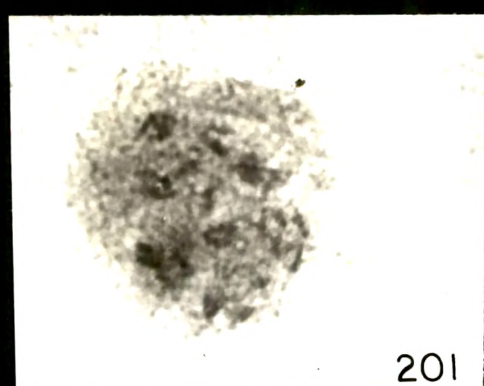
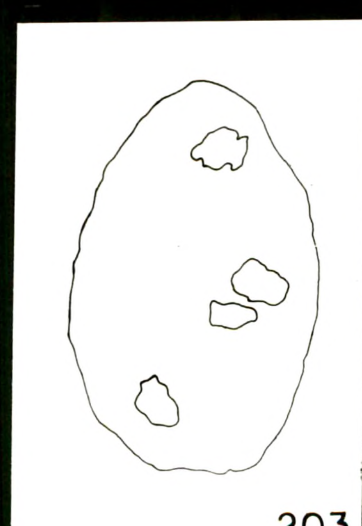


200



201

202



203

PL. 2:42

movement of chromosomes resulting into unequal distribution (Figs. 194, 202), and lagging chromosomes during second meiotic division (Figs. 194, 195 & 200) are the abnormalities observed in some PMCs. Abnormal orientation of metaphase II plates (Figs. 191, 192) and subsequent orientation of chromosomes at telophase II (Fig. 202) is also noticed. Few pollen tetrads having obliquely linear form (Fig. 203) are noticed lying among the normal ones. The determined pollen fertility ranges between 90% to 93.97%.

Solanum nigrum L.

Many chromosome number reports (both 2n and n) for the species, S. nigrum are available. A glance at the literature reveals that as early as 1910, 1916 and 1921 Winkler has reported the 2n number as 24, 36, 48, 72 and 144 for the taxon. Thereafter, different workers viz., Winge (1925), Jörgensen & Crane (1927), Vilmorin & Simonet (1927, 1928), Hruby (1932, 1957), Bhaduri (1933), Tischler (1934), Tokunaga (1934), Janaki-Ammal (1935), Nakamura (1937), Rohweder (1937), Westergaard (1948), Swaminathan (1949), Stebbins & Paddock (1949), Polya (1950), Gottschalk (1954 a & b), Löve (1954), Okabe (1955), Baylis (1958), Diers (1961), Mulligan (1961), Masubuchi (1961), Sharma & Bal (1961), Nanda (1962), Venkateswarlu & Bhirvamurthy (1962), Shibata (1962), Chuang (1963), Bezbaruah & Bezbaruah

(1963), Skalinska (1964), Borgmann (1964), Baquar et al. (1965), Gadella & Kliphuis (1967) have supported these numbers in their studies of the different populations analysed by them. While Chennaveeraiah & Patil (1965, 1968) based on meiotic study of different populations of the taxon, have reported n numbers as 12, 24 and 36. Stray reports of aneuploid populations of S. nigrum are 2n = 36 & 40 (Rai, 1959) and 2n = 56 (Crompton & Basset, 1956). Out of 4 populations analysed in the present study, 3 populations are with 2n = 72 and n = 36. While, the 4th one (Coll. No.02) is with 2n = 24 and n = 12.

Coll. No. 02 :

Karyotype formula : $2n = 24 = C_2^{S'}+C_2^{S}+C_6+D_6+F_6+G_2$

(Table 2:30)

This collection represents a diploid population of the species having 2n = 24 chromosomes in its somatic complement. The karyotype contains chromosomes ranging in length from 1.711 to 3.738 μ having 1.41 μ mean length. There are 4 pairs (D & G-types) with nearly median and 8 pairs (C & F-types) with nearly submedian centromeres. Within the karyotype, are present a pair of satellited (C^{S}-type) and a pair of secondarily constricted ($C^{S'}$-type) chromosomes. The asymmetrical and graded nature of the same is evidenced by TF% (35.50%), L/S ratio 2.18 and the idiogram (Figs. 204,205,206).

Table 2.30. Details of the karyotype analysis of Solanum nigrum L. (Coll. No. 2).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.612	+	1.126	=	3.738	0.43	2.32	100	nsm	C
3, 4	0.721 + 1.576	+	1.081	=	3.378	0.47	2.12	90	nsm	$C^{S'}$
5, 6	2.161	+	1.171	=	3.332	0.54	1.84	89	nsm	C
7, 8	2.207	+	0.901	=	3.108	0.41	2.45	83	nsm	C^{S}
9,10	2.162	+	0.856	=	3.018	0.39	2.52	81	nsm	C
11,12	1.801	+	1.081	=	2.882	0.60	1.66	77	nsm	F
13,14	1.441	+	1.216	=	2.657	0.84	1.18	71	nm	D
15,16	1.531	+	1.081	=	2.612	0.70	1.41	69	nm	D
17,18	1.621	+	0.946	=	2.567	0.58	1.71	68	nsm	F
19,20	1.576	+	0.901	=	2.477	0.57	1.74	66	nsm	F
21,22	1.396	+	0.991	=	2.387	0.71	1.41	63	nm	D
23,24	1.036	+	0.675	=	1.711	0.65	1.53	45	nm	G
	21.841		12.026		33.867					

L/S = 2.18

Mean length = 1.41 μ

T F % = 35.509%

Karyotype formula = $2n = 24 = C_2^{S'} + C_2^{S} + C_6 + D_6 + F_6 + G_2$

Pl. 2: 43

Solanum nigrum

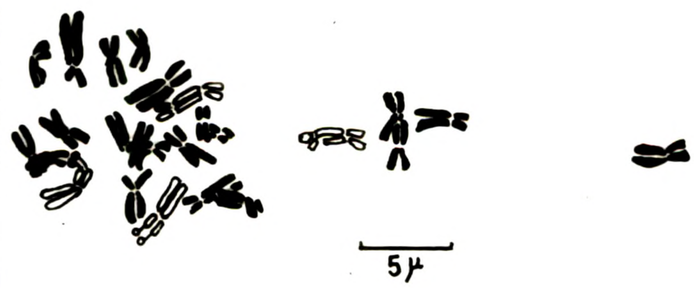
Coll. No. 2 :

(Mitosis)

Fig. 204 - Camera lucida drawing of somatic metaphase plate.

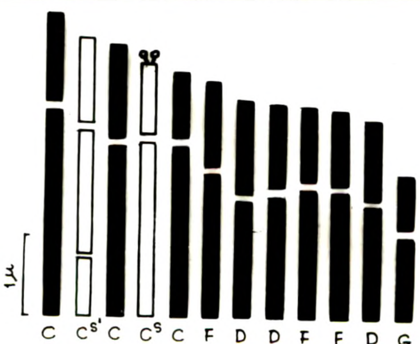
Fig. 205 - Idiogram.

Fig. 206 - Photomicrograph of somatic metaphase plate.



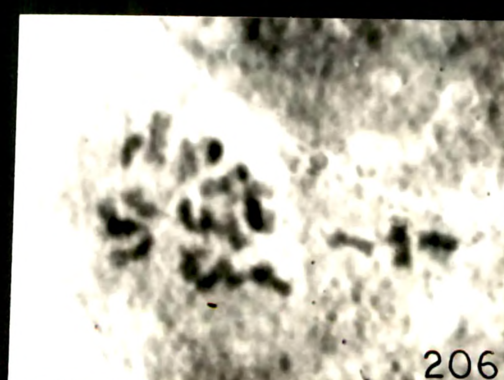
Solanum nigrum (L.) Coll. No. 2

204



S. nigrum L. COLL. NO. 02

205



206

PL. 2 : 43

Coll. Nos. 04, 19 :

Karyotype formulae :

(Coll. No. 19) $2n = 72 = B_8+C_2^{S'}+C_{14}+D_2^S+D_{16}+F_2^S+F_{26}+H_2^S$

(Table 2:31)

(Coll. No. 04) $2n = 72 = C_2^{S'}+C_4+D_{20}+F_2^S+F_{26}+G_2+H_{16}$

(Table 2:32)

Both these collections have 2n = 72 chromosomes in their somatic complements. They share the common feature of having more or less equal number of pairs having nearly median and nearly submedian centromeres. In addition, they also have one pair of secondarily constricted chromosomes ($C^{S'}$-type) in the somatic complement. Calculated values of mean length and L/S ratio are more or less comparable. Of the 2 populations, one representing Coll. No. 19 is having 3 pairs of satellited chromosomes. While, the other representing Coll. No. 04 has only one pair of satellited chromosomes (Figs. 207, 208, 209 and 213, 214, 215 Table 2: 34).

Coll. No. 30 :

Karyotype formula : $2n = 72 + 2B = B_2+C_2^{S'}+C_4+D_{12}+F_{36}+H_6^S+H_{10}$

(Table 2:33).

Table 2: 31. Details of the karyotype analysis of <u>Solanum nigrum</u> L. (Coll. No. 19).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.396 + 1.351	+	1.126	=	3.873	0.41	2.43	100	nsm	$C^{S'}$
3, 4	2.387	+	1.306	=	3.693	0.54	1.82	95	nsm	C
5, 6	1.936	+	1.576	=	3.512	0.81	1.22	90	nm	B
7, 8	2.162	+	1.306	=	3.468	0.60	1.65	89	nsm	C
9,10	1.982	+	1.486	=	3.468	0.74	1.33	89	nm	B
11,12	1.982	+	1.441	=	3.423	0.72	1.37	88	nm	B
13,14	1.982	+	1.351	=	3.333	0.68	1.46	86	nm	B
15,16	2.026	+	1.171	=	3.197	0.57	1.73	82	nsm	C
17,18	1.936	+	1.171	=	3.107	0.60	1.65	80	nsm	C
19,20	2.072	+	0.991	=	3.063	0.47	2.09	79	nsm	C
21,22	1.982	+	1.081	=	3.063	0.54	1.83	79	nsm	C
23,24	2.026	+	0.991	=	3.017	0.48	2.04	77	nsm	C
25,26	1.982	+	0.945	=	2.927	0.47	2.09	75	nsm	F
27,28	1.801	+	1.126	=	2.927	0.62	1.59	75	nm	D
29,30	1.892	+	0.945	=	2.837	0.49	2.0	73	nsm	F
31,32	1.756	+	1.081	=	2.837	0.61	1.62	73	nm	D
33,34	1.621	+	1.171	=	2.792	0.72	1.38	72	nm	D
35,36	1.756	+	0.991	=	2.747	0.56	1.77	70	nsm	F
37,38	1.711	+	0.991	=	2.702	0.59	1.72	69	nsm	F
39,40	1.666	+	1.036	=	2.702	0.62	1.60	69	nm	D

Contd....

Table 2:31. Contd.

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
41,42	1.621	+ 1.081	= 2.702	0.66	1.49	69	nm	D
43,44	1.666	+ 0.991	= 2.657	0.59	1.68	68	nsm	F
45,46	1.666	+ 0.991	= 2.657	0.59	1.68	68	nsm	F
47,48	1.666	+ 0.991	= 2.657	0.59	1.68	68	nsm	F
49,50	1.441	+ 0.945	= 2.386	0.65	1.52	61	nm	D
51,52	1.621	+ 0.721	= 2.342	0.44	2.24	60	nsm	F
53,54	1.351	+ 0.991	= 2.342	0.73	1.36	60	nm	D
55,56	1.441	+ 0.856	= 2.297	0.59	1.69	59	nsm	F
57,58	1.441	+ 0.766	= 2.207	0.53	1.88	56	nsm	F^S
59,60	1.441	+ 0.766	= 2.207	0.53	1.88	56	nsm	F
61,62	1.306	+ 0.856	= 2.162	0.65	1.52	55	nm	D^S
63,64	1.441	+ 0.675	= 2.116	0.46	2.13	54	nsm	F
65,66	1.306	+ 0.766	= 2.072	0.58	1.70	53	nsm	F
67,68	1.216	+ 0.856	= 2.072	0.70	1.42	53	nm	D
69,70	1.261	+ 0.766	= 2.027	0.60	1.64	52	nsm	F
71,72	1.351	+ 0.585	= 1.936	0.43	2.30	49	nsm	H^S
	62.641	36.886	99.527					

L/S = 2.01

Mean length = 1.38 μ

T F % = 37.06 %

Karyotype formula = 2n = 72 = $B_8 + C_2^{S'} + C_{14} + D_2^S + D_{16} + F_2^S + F_{26} + H_2^S$

Table 2:32. Details of the karyotype analysis of <u>Solanum nigrum</u> L. (Red veined form) (Coll. No. 04).

Chromosome pair	Length in u: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	2.162	+	0.990	=	3.152	0.45	2.18	100	nsm	C
3, 4	0.990 + 1.171	+	0.946	=	3.107	0.43	2.28	98	nsm	$C^{S'}$
5, 6	2.162	+	0.856	=	3.018	0.39	2.52	95	nsm	C
7, 8	1.846	+	1.036	=	2.882	0.56	1.78	91	nsm	F
9,10	1.846	+	0.946	=	2.792	0.51	1.95	88	nsm	F
11,12	1.756	+	0.901	=	2.657	0.51	1.94	84	nsm	F
13,14	1.756	+	0.856	=	2.612	0.48	2.15	82	nsm	F
15,16	1.621	+	0.991	=	2.612	0.61	1.63	82	nm	D
17,18	1.621	+	0.991	=	2.612	0.61	1.63	82	nm	D
19,20	1.621	+	0.946	=	2.567	0.58	1.71	81	nsm	F
21,22	1.576	+	0.946	=	2.522	0.60	1.66	80	nsm	F
23,24	1.486	+	0.991	=	2.477	0.66	1.49	78	nm	D
25,26	1.666	+	0.766	=	2.432	0.54	1.84	77	nsm	F
27,28	1.666	+	0.721	=	2.387	0.43	2.31	75	nsm	F
29,30	1.531	+	0.856	=	2.387	0.55	1.78	75	nsm	F^S
31,32	1.576	+	0.811	=	2.387	0.51	1.94	75	nsm	F
33,34	1.351	+	1.036	=	2.387	0.76	1.30	75	nm	D
35,36	1.576	+	0.766	=	2.342	0.48	2.05	74	nsm	F
37,38	1.306	+	1.036	=	2.342	0.79	1.26	74	nm	D
39,40	1.531	+	0.766	=	2.297	0.50	1.99	72	nsm	F

Contd...

Table 2:32. Contd.

Chromosome pair	Length in u Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
41,42	1.666	+	0.585	=	2.251	0.35	2.84	71	nsm	F
43,44	1.261	+	0.901	=	2.162	0.71	1.39	68	nm	D
45,46	1.261	+	0.901	=	2.162	0.71	1.39	68	nm	D
47,48	1.306	+	0.811	=	2.117	0.62	1.61	67	nm	D
49,50	1.306	+	0.721	=	2.027	0.55	1.81	64	nsm	F
51,52	1.216	+	0.811	=	2.027	0.66	1.49	64	nm	D
53,54	1.216	+	0.811	=	2.027	0.66	1.49	64	nm	D
55,56	1.306	+	0.631	=	1.937	0.48	2.06	61	nsm	H
57,58	1.351	+	0.541	=	1.892	0.40	2.49	60	nsm	H
59,60	1.306	+	0.586	=	1.892	0.44	2.22	60	nsm	H
61,62	1.126	+	0.721	=	1.847	0.64	1.56	58	nm	G
63,64	1.261	+	0.541	=	1.802	0.42	2.33	57	nsm	H
65,66	1.171	+	0.631	=	1.802	0.53	1.85	57	nsm	H
67,68	1.171	+	0.585	=	1.756	0.49	2.0	55	nsm	H
69,70	1.036	+	0.541	=	1.577	0.52	1.91	50	nsm	H
71,72	0.991	+	0.450	=	1.441	0.45	2.20	45	nsm	H
	53.678		29.012		82.690					

L/S = 2.18

Mean length = 1.14 u

T F % = 35.08%

Karyotype formula = 2n = 72 = $C_2^{S'} + C_4 + D_{20} + F_2^S + F_{26} + G_2 + H_{16}$

Table 2:33. Details of the karyotype analysis of <u>Solanum nigrum</u> L. (Coll. No. 30).

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm +	Short Arm =	Total length	R_1	R_2			
1, 2	1.126 + 1.351 +	1.081 =	3.558	0.43	2.29	100	nsm	$C^{S'}$
3, 4	2.162 +	1.306 =	3.468	0.60	1.65	97	nsm	C
5, 6	1.981 +	1.216 =	3.197	0.61	1.62	89	nm	B
7, 8	1.981 +	1.081 =	3.062	0.54	1.83	86	nsm	C
9,10	1.756 +	1.081 =	2.837	0.61	1.62	79	nm	D
11,12	1.666 +	0.946 =	2.612	0.56	1.76	73	nsm	F
13,14	1.711 +	0.856 =	2.567	0.50	1.99	72	nsm	F
15,16	1.666 +	0.901 =	2.567	0.54	1.84	72	nsm	F
17,18	1.711 +	0.811 =	2.522	0.47	2.10	70	nsm	F
19,20	1.711 +	0.766 =	2.477	0.44	2.23	69	nsm	F
21,22	1.666 +	0.766 =	2.432	0.45	2.16	68	nsm	F
23,24	1.711 +	0.676 =	2.387	0.39	2.53	67	nsm	F
25,26	1.576 +	0.811 =	2.387	0.51	1.94	67	nsm	F
27,28	1.531 +	0.856 =	2.387	0.55	1.78	67	nsm	F
29,30	1.486 +	0.901 =	2.387	0.60	1.64	67	nsm	F
31,32	1.396 +	0.946 =	2.342	0.67	1.47	65	nm	D
33,34	1.621 +	0.676 =	2.297	0.41	2.39	64	nsm	F
35,36	1.576 +	0.721 =	2.297	0.45	2.18	64	nsm	F
37,38	1.396 +	0.901 =	2.297	0.64	1.54	64	nm	D
39,40	1.351 +	0.946 =	2.297	0.70	1.42	64	nm	D

Contd...

Table 2.33. Contd.

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm	+ Short Arm	= Total length	R_1	R_2			
41,42	1.486	+ 0.766	= 2.252	0.51	1.93	63	nsm	F
43,44	1.576	+ 0.631	= 2.207	0.40	2.49	62	nsm	F
45,46	1.441	+ 0.766	= 2.207	0.53	1.88	62	nsm	F
47,48	1.351	+ 0.856	= 2.207	0.63	1.57	62	nm	D
49,50	1.396	+ 0.766	= 2.162	0.54	1.82	60	nsm	F
51,52	1.261	+ 0.901	= 2.162	0.71	1.39	60	nm	D
53,54	1.441	+ 0.675	= 2.116	0.46	2.13	59	nsm	F
55,56	1.306	+ 0.766	= 2.072	0.58	1.70	58	nsm	F
57,58	1.351	+ 0.631	= 1.982	0.46	2.14	55	nsm	H^S
59,60	1.306	+ 0.676	= 1.982	0.51	1.93	55	nsm	H^S
61,62	1.261	+ 0.721	= 1.982	0.57	1.74	55	nsm	H
63,64	1.306	+ 0.631	= 1.937	0.48	2.06	54	nsm	H
65,66	1.261	+ 0.676	= 1.937	0.53	1.86	54	nsm	H
67,68	1.306	+ 0.631	= 1.937	0.48	2.06	54	nsm	H
69,70	1.351	+ 0.541	= 1.892	0.40	2.49	53	nsm	H^S
71,72	1.216	+ 0.676	= 1.892	0.55	1.79	53	nsm	H
	55.748	29.555	85.303					

L/S = 1.88

Mean length = 1.18 μ

T F % = 34.64%

Karyotype formula = 2n = 72+2B = $B_2 + C_2^{S'} + C_4 + D_{12} + F_{36} + H_6^S + H_{10}$

Pl. 2: 44

Solanum nigrum

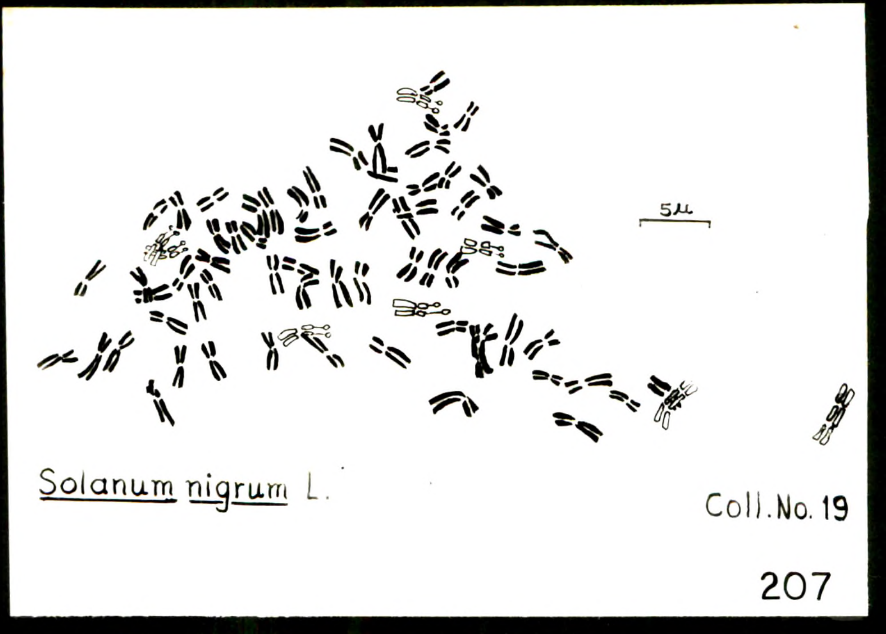
Coll. No. 19 :

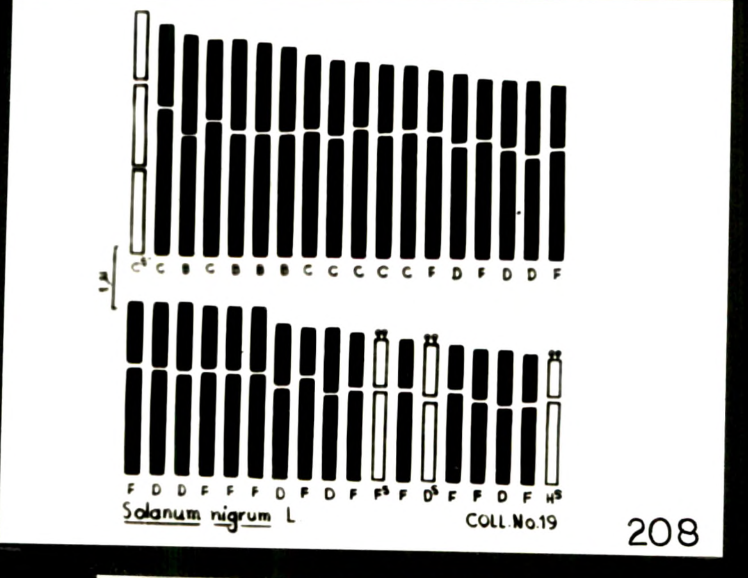
(Mitosis)

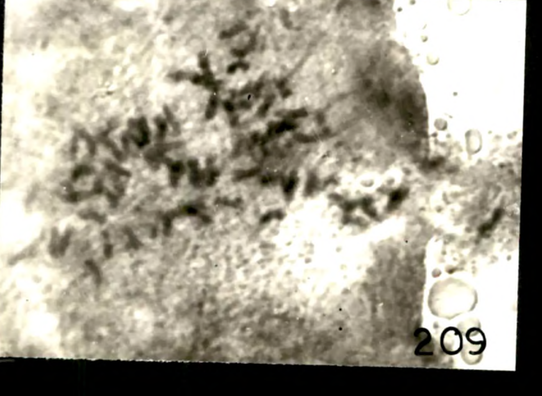
Fig. 207 - Camera lucida drawing of somatic metaphase plate.

Fig. 208 - Idiogram.

Fig. 209 - Photomicrograph of somatic metaphase plate.


5μ
Solanum nigrum L.
Coll. No. 19
207


Solanum nigrum L
COLL. No. 19
208


209

PL. 2 : 44

Pl. 2: 45

Solanum nigrum

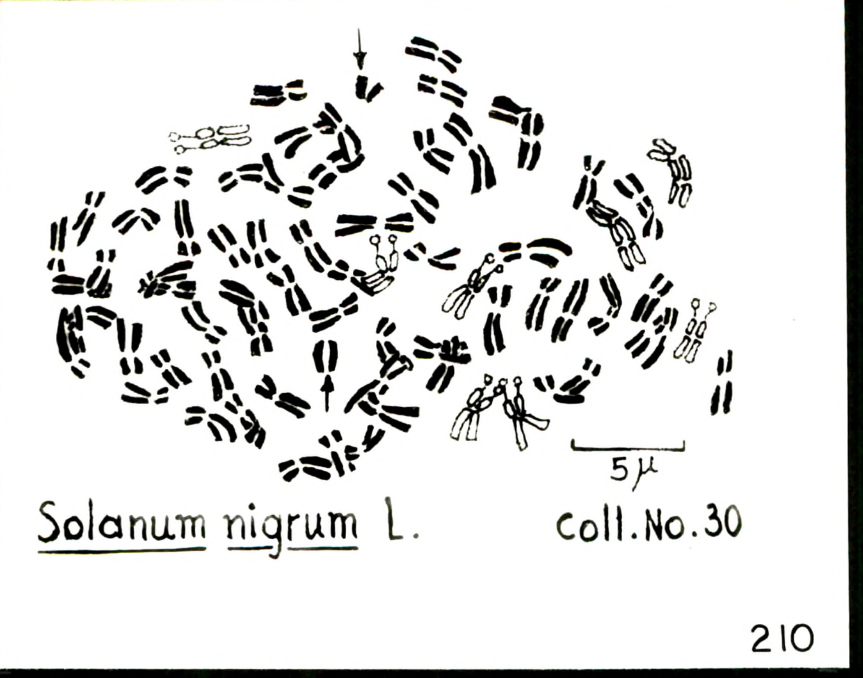
Coll. No. 30 :

(Mitosis)

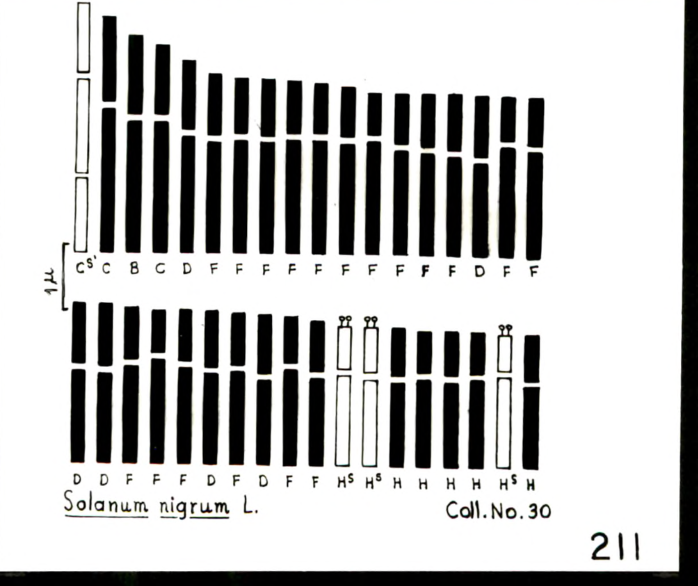
Fig. 210 - Camera lucida drawing of somatic metaphase plate.

Fig. 211 - Idiogram.

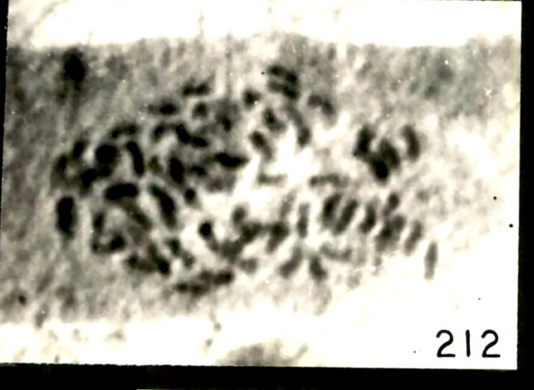
Fig. 212 - Photomicrograph of somatic metaphase plate.



210



211



212

PL. 2:45

Pl. 2: 46

Solanum nigrum

Coll. No. 4 :

(Mitosis)

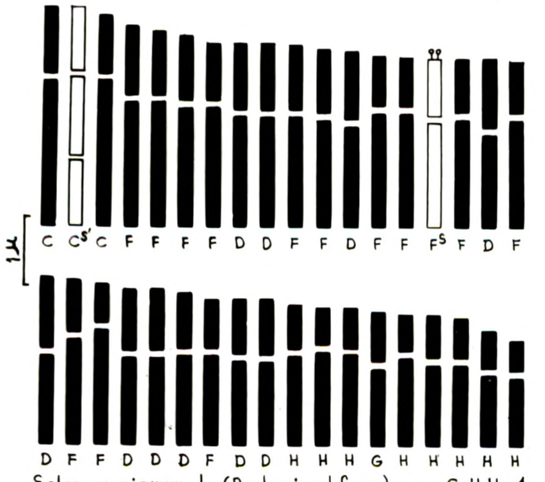
Fig. 213 - Camera lucida drawing of somatic metaphase plate.

Fig. 214 - Idiogram.

Fig. 215 - Photomicrograph of somatic metaphase plate.

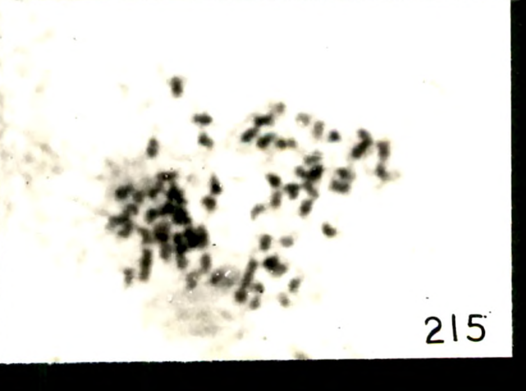
Solanum nigrum L. (Red veined form) Coll. No. 4

213



Solanum nigrum L. (Red veined form) Coll. No. 4

214



215

PL. 2:46

The karyotype of this population grossly resembles those of other 2, hexaploid ones. However, few structural differences are distinctive to distinguish it from them. The karyotype has only 7 pairs (B & D-types) having nearly median and 29 pairs (C, F & H-types) with nearly submedian centromeres. Moreover, 2-B chromosomes recorded in the somatic metaphase plates are altogether absent in other 2 populations.

Comparison of the morphological and karyotypic data (Table 2:34) reveals the polymorphic nature of the taxon. Coll. No. 02 representing a diploid population morphologically resembles the hexaploid ones represented by coll. Nos. 19 and 30. Coll. No. 04, also a hexaploid one, differs from other 3 collections in having distinct red veined leaves.

The presence of 2 ecotypes and at least 3 cytotypes among the populations of S. nigrum in Gujarat, is suggested from the above mentioned data.

Meiosis in both the forms i.e. diploid and hexaploid is more or less regular. In diploid population (coll. No. 2), 12 bivalents are noticed at diakinesis. One or two bivalents are near the nucleolus at diakinesis (Figs. 216 & 217). At metaphase I 12 bivalents are observed lying at equatorial plane (Fig. 218). Only in few PMCs during second meiotic division abnormal orientation and non synchronised movement of chromosomes (Fig. 219) is seen.

Table 2:34. Comparison of somatic chromosomes of different populations of <u>Solanum nigrum</u> L.

Populations	Somatic number (2n)	nm Types			nsm Types			Chromosomes with secondary constrictions	Chromosomes with satellites Types				Absolute length in μ	Mean length in μ	L/S
		B	D	G	C	F	H	Type $C^{S'}$	C^S	D^S	F^S	H^S			
Coll.No.02	24	-	6	2	10	6	-	2	2	-	-	-	33.867	1.41	2.18
Coll.No.04	72	-	20	2	6	28	16	2	-	-	2	-	82.690	1.14	2.18
Coll.No.19	72	8	18	-	16	28	2	2	-	2	2	2	99.527	1.38	2.01
Coll.No.30	72+2B	2	12	-	6	36	16	2	-	-	-	6	85.303	1.18	1.88

Pl. 2: 47

Solanum nigrum

Coll. No. 2 :

(Meiosis)

Fig. 216 and Fig. 217 - Photomicrograph & camera lucida drawing of PMC showing 12 bivalents at early diakinesis.

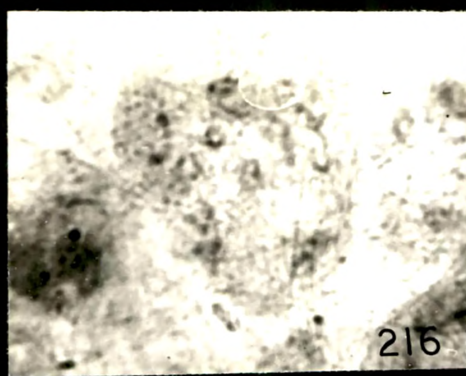
Fig. 218 - " " 12 bivalents at metaphase I. (Side view).

Fig. 219 - " " abnormal orientation and non synchronised movements of chromosomes at telophase II.

Coll. No. 19 :

Fig. 220 - " " 36 bivalents at early diakinesis; note one bivalent near the nucleolus.

Fig. 221 - " " 36 bivalents at diakinesis.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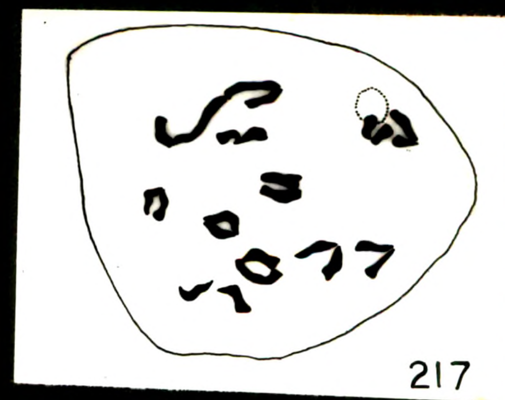
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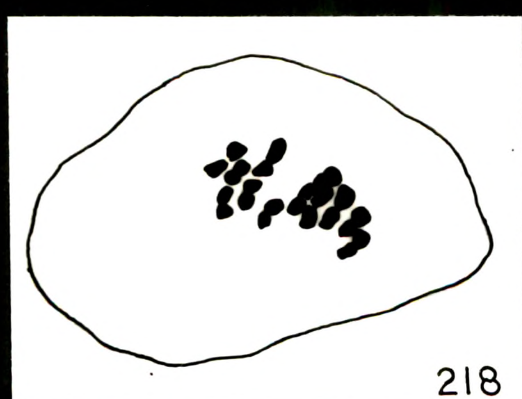
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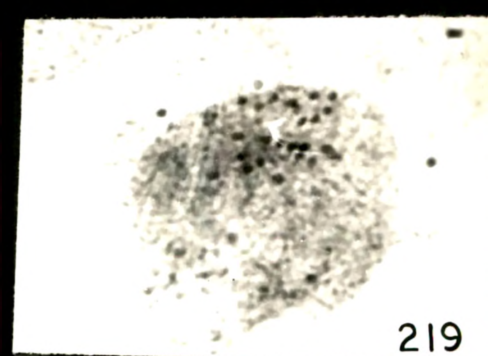
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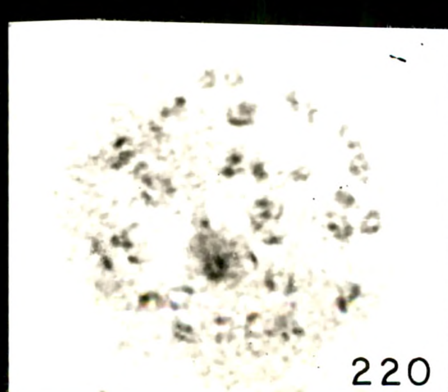
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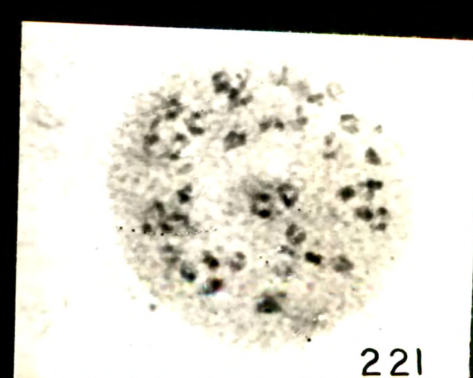

221

PL. 2: 47

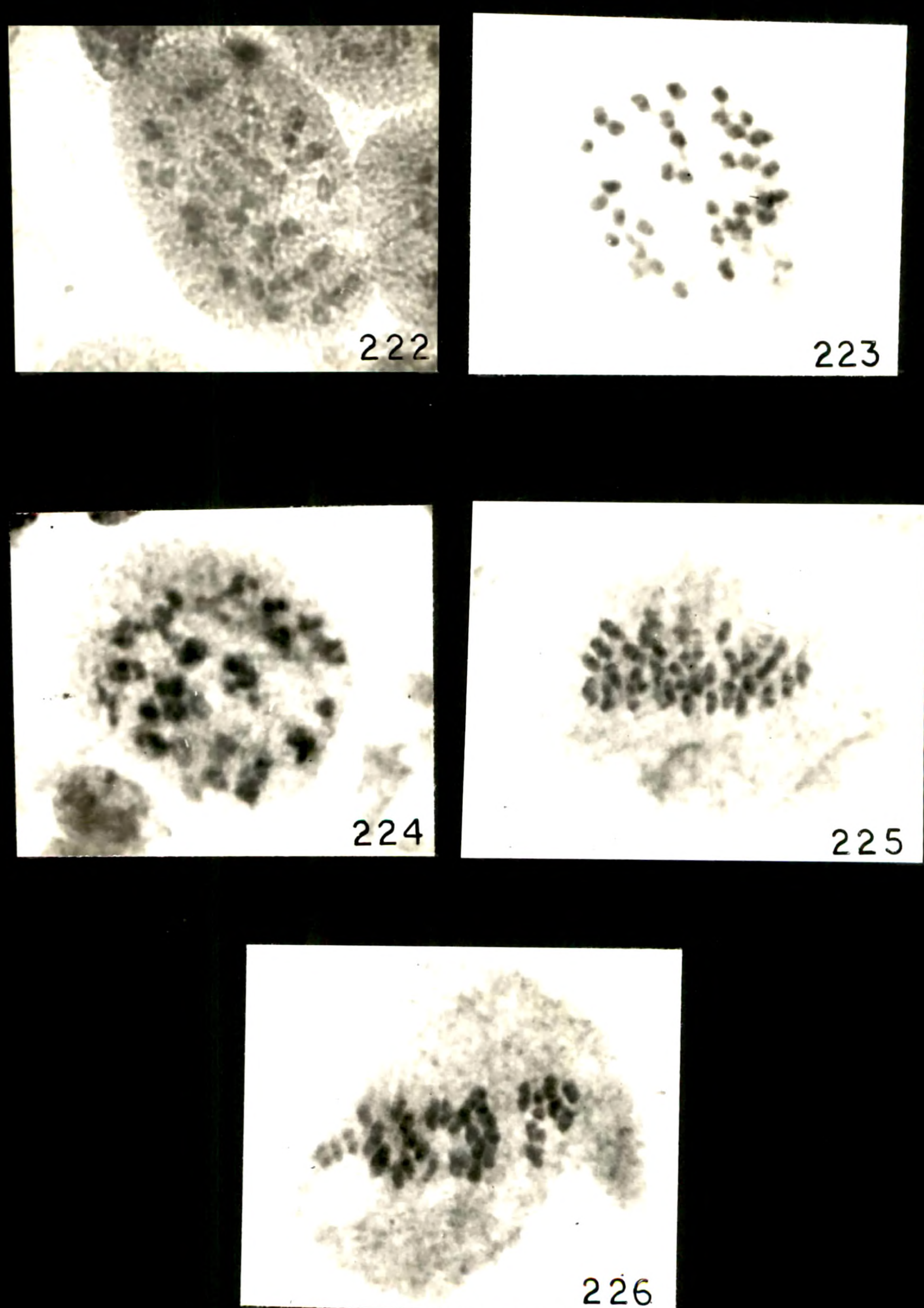
Pl. 2:48

Solanum nigrum

Coll. No. 4 :

(Meiosis)

Fig. 222 and 223 -	PMC	showing	36 bivalents at early and late diakinesis, few interbivalent connections at late diakinesis.
Fig. 224 -	"	"	secondary groupings of bivalents at late diakinesis.
Fig. 225 and 226 -	PMCs	"	36 bivalents at metaphase I (Side view)



PL. 2:48

In all the 3 hexaploid collections represented by coll. Nos. 4, 19 and 30, regular behaviour of meiotic chromosomes is observed. 36 bivalents, with one or two near the nucleolus, at diakinesis (Figs. 220, 221, 222) and at metaphase I (Figs. 225 & 226) are commonly seen. Only abnormalities observed in few pollen mother cells are, interbivalent connections and secondary groupings of bivalents, at late diakinesis (Figs. 222, 223 & 224). The determined pollen fertility 96.96% indicates that above mentioned abnormalities occur in a very low percentage of PMCs.

Solanum viarum Dunal

The earlier reports of chromosome ~~n~~ numbers for the species are n = 12 and 2n = 24 by Bezbaruah & Bezbaruah (1963), Chennaveeraiah & Krishnappa (1966, 1970, 1976) and n = 12 by Mitra (1966). The present study confirms the earlier reports of n = 12 and 2n = 24.

Coll. No. 25 :

Karyotype formula : $2n = 24 = C_8+C_2^{S'}+C_2^{S}+D_4+F_8$

(Table 2:35)

24 chromosomes of the somatic complement are distributed in 3 types viz., C, D and F representing medium sized

Table 2.35. Details of the karyotype analysis of <u>Solanum viarum</u> Dun. (Coll. No. 25).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	Arm Ratios R_2	Relative length	Centromere	Type
1, 2	$^{0.901}_{+1.306}$	+ 1.261	= 3.468	0.571	1.74	100	nsm	$C^{S'}$
3, 4	2.117	+ 1.261	= 3.378	0.59	1.67	97	nsm	C
5, 6	2.342	+ 0.991	= 3.333	0.42	2.36	96	nsm	C
7, 8	2.027	+ 1.126	= 3.153	0.49	1.80	90	nsm	C
9,10	2.027	+ 0.991	= 3.018	0.46	2.04	87	nsm	C
11,12	2.162	+ 0.856	= 3.018	0.39	2.47	87	nsm	C^S
13,14	1.666	+ 1.081	= 2.747	0.64	1.54	79	nm	D
15,16	1.576	+ 0.991	= 2.567	0.62	1.59	74	nm	D
17,18	1.621	+ 0.856	= 2.477	0.52	1.89	71	nsm	F
19,20	1.802	+ 0.675	= 2.477	0.37	2.66	71	nsm	F
21,22	1.441	+ 0.856	= 2.297	0.59	1.68	66	nsm	F
23,24	1.396	+ 0.766	= 2.162	0.54	1.82	62	nsm	F
	22.384	11.711	34.095					

L/S = 1.60

Mean length = 1.42 μ

T F % = 34.34 %

Karyotype formula = 2n = 24 = $C_2^{S'} + C_2^S + C_8 + D_4 + F_8$

chromosomes. Among these 10 pairs of C & F-types are with nearly submedian and only 2 pairs of D-type are with nearly median centromeres. Both satellited and secondarily constricted pairs present within the complement belong to C-type of chromosomes. The chromosome length ranges from 2.162 to 3.468 μ having a mean length of 1.42 μ. Lesser values of L/S ratio and relative length indicate smooth gradation of the karyotype. The TF% of 34.34% depicts the asymmetrical nature of the karyotype which is also evident in the idiogram (Figs. 227, 228).

Comparison of presently studied population and the one worked out earlier by Krishnappa & Chennaveeraiah (1976) reveals some differences. Two pairs of chromosomes with nearly median centromeres observed in the present study were not observed by the earlier workers. Further in the present study one pair of secondarily constricted chromosome, in addition to a satellited pair, is observed. However, accessory chromosome reported by Chennaveeraiah & Krishnappa (1965) in the Conoor population are not observed in Dehradun population, coll. No. 25, studied presently.

On the whole meiotic behaviour is more or less regular. 12 distinct bivalents are noticed at diakinesis and metaphase I (Figs. 229 & 230). In majority of the PMCs subsequent stages leading to the formation of tetrad exhibited normal behaviour (Figs. 233 & 234). However, few abnormalities such as early

Pl. 2: 49

Solanum viarum

Coll. No. 25 :

(Mitosis)

Fig. 227 - Camera lucida drawing of the somatic metaphase plate.

Fig. 228 - Idiogram.

(Meiosis)

Fig. 229 - PMC showing 12 bivalents at diakinesis. Note one bivalent near the nucleolus.

Fig. 230 - " " one non congressional bivalent at metaphase I.

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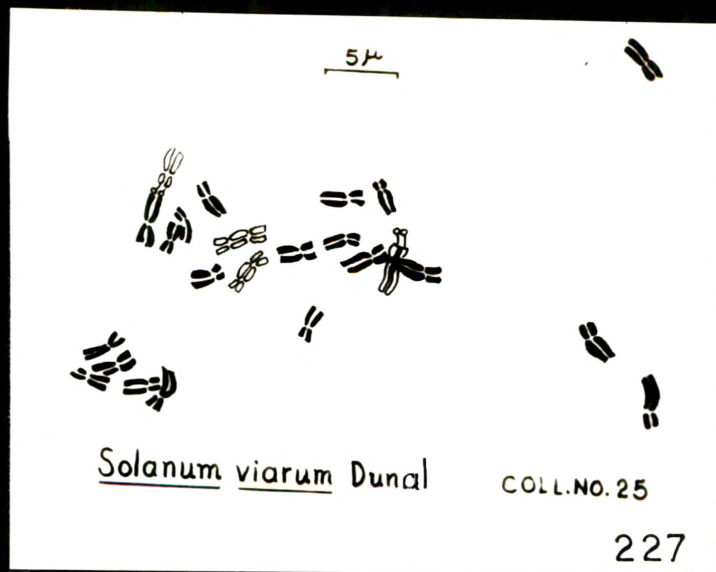

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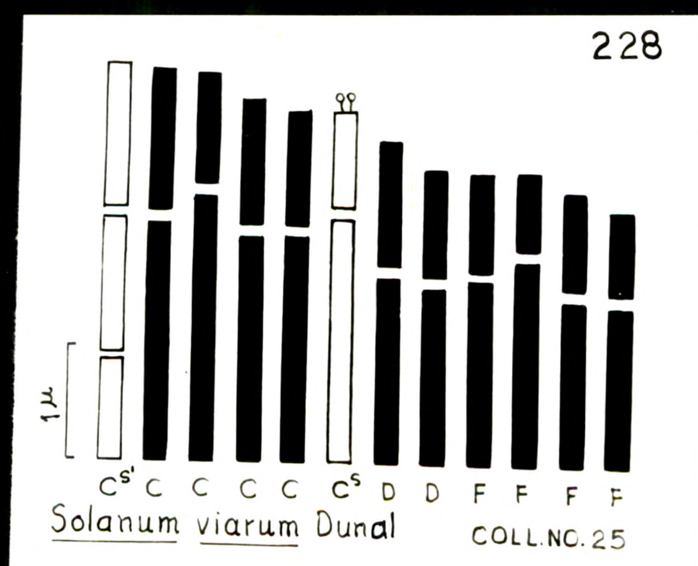

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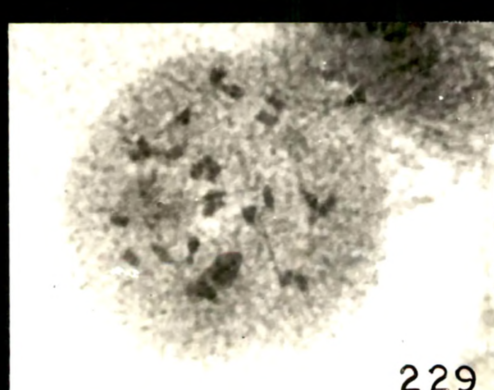
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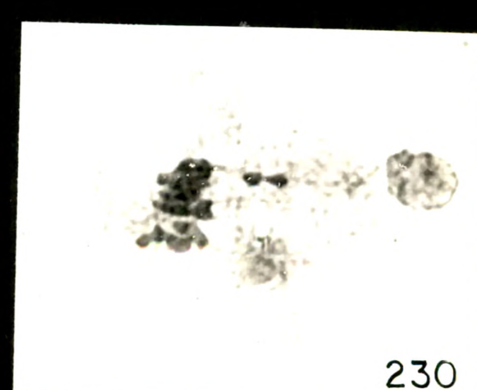
230

PL. 2 : 49

Solanum viarum

Coll. No. 25 :

(Meiosis)

Fig. 231 - PMC showing secondary grouping of bivalents at diakinesis.
$({}^{1}{}_{(III)} + {}^{4}{}_{(II)} + {}^{1}{}_{(I)})$

Fig. 232 - " " secondary grouping of bivalents.
$({}^{1}{}_{(V)} + {}^{1}{}_{(IV)} + {}^{1}{}_{(III)})$

Fig. 233 - " " normal distribution of chromosomes at telophase II.

Fig. 234 - " " tetrad formation.

Solanum trilobatum

Coll. No. 10 :

(Mitosis)

Fig. 235 - Camera lucida drawing of somatic metaphase.

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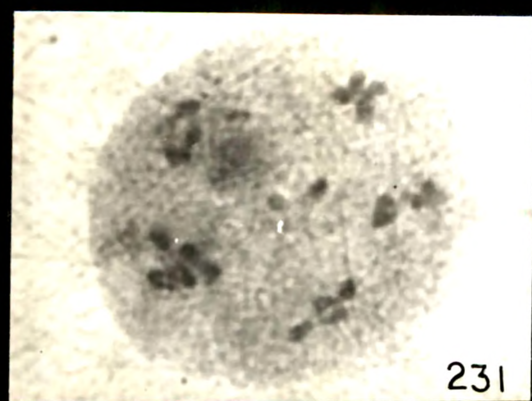
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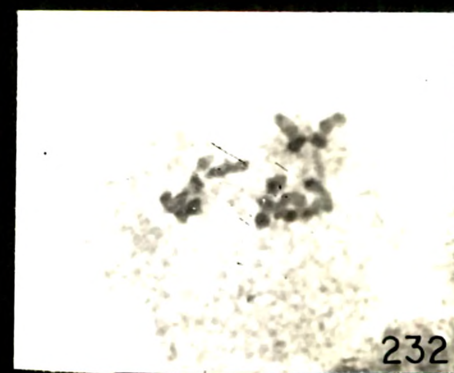
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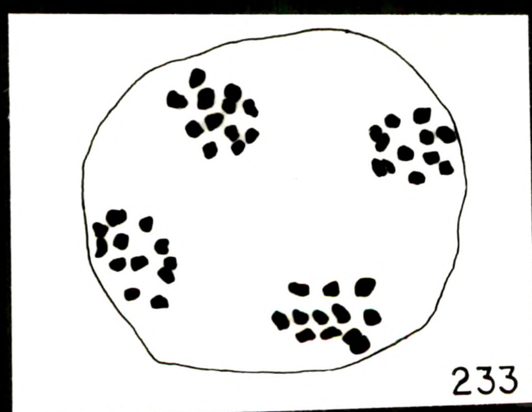
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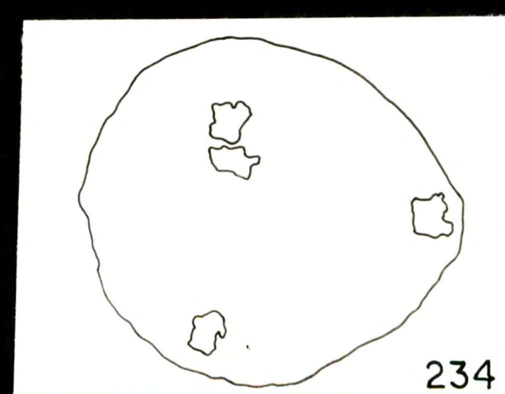
234

235

2·50

PL. 2 : 50

separation of few bivalents at late diakinesis leading to the formation of univalents (Fig. 229), various groupings of bivalents (Figs.231 & 232), non congressional bivalent at metaphase I (Fig. 230) are noticed. The determined pollen fertility for the species is 90.36%.

Solanum trilobatum L.

Based on meiotic study, Bhaduri (1933) reported n = 12 for the taxon and the same was confirmed by Rao in 1962. Chennaveeraiah & Krishnappa (1966, 1976) confirmed the n number and also reported the somatic number as 2n = 24. The above mentioned numbers are confirmed by the present study of the 2 populations.

Coll. No. 10 :

Karyotype formula : $2n = 24 = B_2{+}D_2^{S'}{+}D_2{+}F_{12}{+}G_2{+}H_2^{S}{+}H_2$

(Table 2:36)

The chromosomes of the somatic complement exhibit a wide length range between 1.666 to 3.062 μ having a mean length of 1.26 μ. The complement contains 4 pairs (B, D & G-types) of chromosomes with nearly median and 8 pairs (F & H-types) with nearly submedian centromeres. Among these, one pair $D^{S'}$-type has secondary constrictions on long arms and another pair H^{S}-type is with satellites. Comparatively high

Table 2.36. Details of the karyotype analysis of <u>Solanum trilobatum</u> L. (Coll. No. 10).

Chromosome pair	Length in μ: Long Arm	+ Short Arm	= Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	1.891	+ 1.171	= 3.062	0.61	1.61	100	nm	B
3, 4	0.675 + 1.081	+ 1.081	= 2.837	0.61	1.62	92	nm	$D^{S'}$
5, 6	1.711	+ 1.036	= 2.747	0.60	1.65	89	nsm	F
7, 8	1.666	+ 0.991	= 2.657	0.59	1.68	86	nsm	F
9, 10	1.666	+ 0.856	= 2.522	0.51	1.94	84	nsm	F
11,12	1.621	+ 0.901	= 2.522	0.55	1.80	84	nsm	F
13,14	1.441	+ 1.036	= 2.477	0.72	1.39	80	nm	D
15,16	1.576	+ 0.856	= 2.432	0.54	1.84	79	nsm	F
17,18	1.441	+ 0.856	= 2.297	0.59	1.68	75	nsm	F
19,20	1.171	+ 0.720	= 1.891	0.61	1.62	61	nm	G
21,22	1.306	+ 0.540	= 1.846	0.41	2.41	60	nsm	H^S
23,24	1.081	+ 0.585	= 1.666	0.54	1.84	54	nsm	H
	18.327	10.629	28.956					

L/S = 1.83

Mean length = 1.26 μ

T F % = 36.71 %

Karyotype formula = $2n = 24 = B_2 + D_2^{S'} + D_2 + F_{12} + G_2 + H_2^S + H_2$

TF% and L/S ratio indicate the less evolved nature of the karyotype. Like many other species of Solanum the karyotype is asymmetrical but shows abrupt gradation at some points and the same is reflected in the idiogram of the species (Figs. 235, 236 & 237).

Coll. No. 48 :

Karyotype formula : $2n = 24 = A_2+C_2+D_2^{S'}+D_2^{S}+D_6+F_{10}$

(Table 2:37)

This collection differs from coll. No. 10 in some striking structural details. The chromosome length of this collection varies between 2.116 and 4.098 μ. Within the complement there are 5 pairs (D-type) of chromosomes with nearly median and 7 pairs belonging to A, C and F-types with nearly submedian centromeres. The somatic complement of this collection is distinct in having one pair of chromosome, A-type, of 4.098 μ length, not observed in any species of Solanum studied presently. Both the collections share the common feature as regard the satellited and secondarily constricted pairs and more or less comparable values of TF% and L/S ratio (Table 2:38) (Figs. 238, 239 & 240).

The present analysis of the two populations differs from that of Krishnappa & Chennaveeraiah (1976) in having only one pair of satellited chromosomes. A pair of secondarily constricted chromosome observed in the present study is not mentioned

Pl. 2: 51

Solanum trilobatum

Coll. No. 10 (Contd.) :

Mitosis)

Fig. 236 - Idiogram.

Fig. 237 - Photomicrograph of somatic metaphase plate.

Coll. No. 48 :

Fig. 238 - Camera lucida drawing of somatic metaphase. plate.

Fig. 239 - Photomicrograph of the same.

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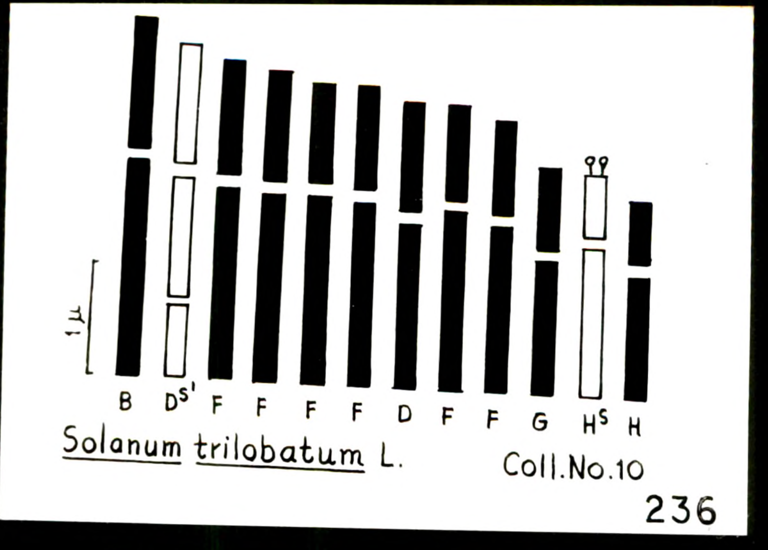
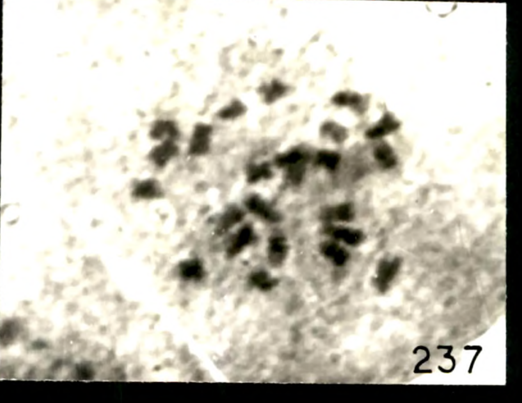

1 μ
B D$^{s'}$ F F F F D F F G H^{s} H
Solanum trilobatum L.
Coll.No.10
236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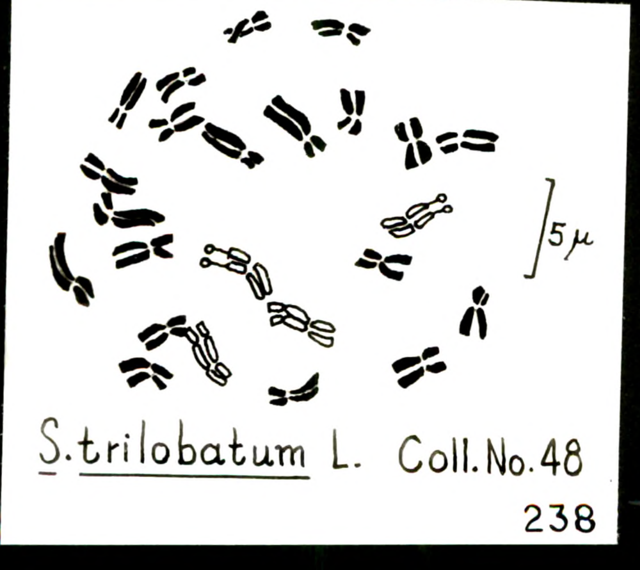
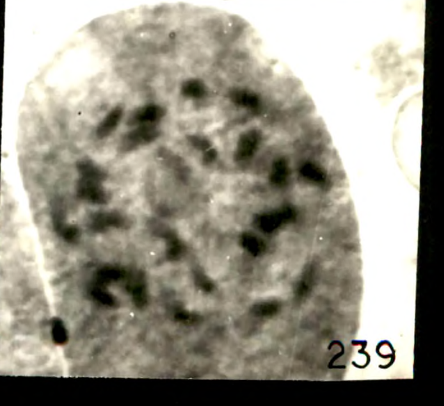

5 μ
S.trilobatum L. Coll.No.48
238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PL. 2 : 51

Table 2:37. Details of the karyotype analysis of <u>Solanum trilobatum</u> L. (Coll. No. 48).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.837	+	1.261	=	4.098	0.44	2.24	100	nsm	A
3, 4	2.252	+	0.901	=	3.153	0.40	2.49	76	nsm	C
5, 6	0.540 + 1.171	+	1.216	=	2.927	0.71	1.40	71	nm	$D^{S'}$
7, 8	1.756	+	0.991	=	2.747	0.56	1.77	67	nsm	F
9,10	1.711	+	0.991	=	2.702	0.57	1.72	65	nsm	F
11,12	1.531	+	1.036	=	2.567	0.67	1.47	62	nm	D^{S}
13,14	1.576	+	0.991	=	2.567	0.62	1.59	62	nm	D
15,16	1.486	+	0.945	=	2.431	0.63	1.52	59	nm	D
17,18	1.486	+	0.720	=	2.206	0.48	2.06	53	nsm	F
19,20	1.261	+	0.945	=	2.206	0.74	1.33	53	nm	D
21,22	1.396	+	0.720	=	2.116	0.51	1.93	51	nsm	F
23,24	1.351	+	0.765	=	2.116	0.56	1.76	51	nsm	F
	20.354		11.482		31.836					

L/S = 1.93

Mean length = 1.33 μ

T F % = 36.06 %

Karyotype formula = $2n = 24 = A_2 + B_2 + D^{S'}_2 + D^{S}_2 + D_6 + F_{10}$

Table 2:38. Comparison of the somatic chromosomes of the populations of *Solanum trilobatum* L.

Populations	Somatic number (2n)	n m			n s m				Chromosomes with secondary constrictions	Chromosomes with satellites		Absolute length in μ	Mean length in μ	L/S
		Types			Types				Type	Types				
		B	D	G	A	C	F	H	D^S	D^S	H^S			
Coll.No.10	24	2	4	2	-	-	12	4	2	-	2	28.956	1.26	1.83
Coll.No.48	24	-	10	-	2	2	10	-	2	2	-	31.836	1.33	1.93

Solanum trilobatum

Coll. No. 48 (Contd.) :

(Mitosis)

Fig. 240 - Idiogram.

Coll. No. 10 :

(Meiosis)

Fig. 241 and 242 - PMC showing 12 distinct bivalents at late diakinesis.

Fig. 243 - " " equal distribution at telophase I.

Fig. 244 - " " non synchronised movement of the 2 metaphase plates and abnormal orientation during second meiotic division.

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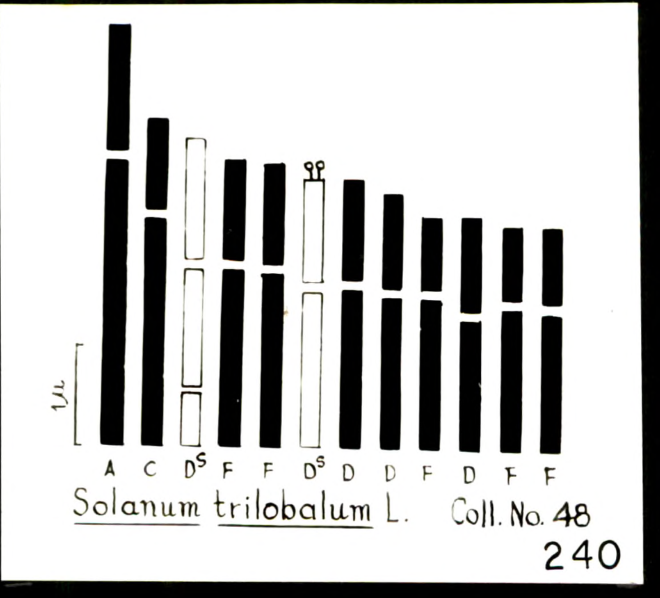

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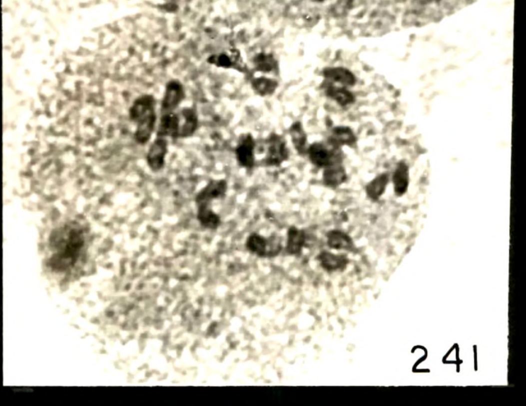
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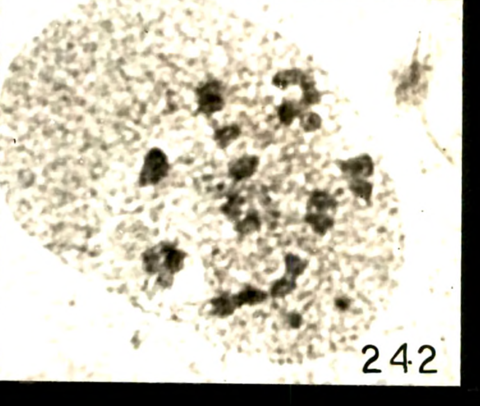
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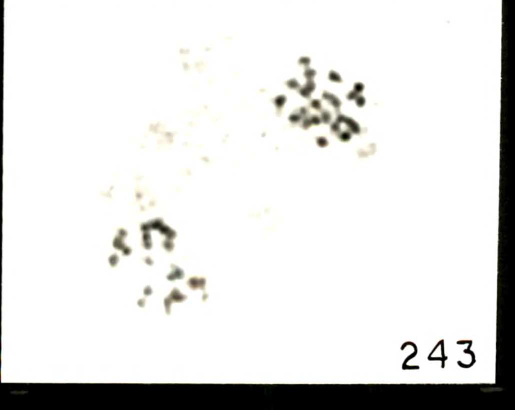
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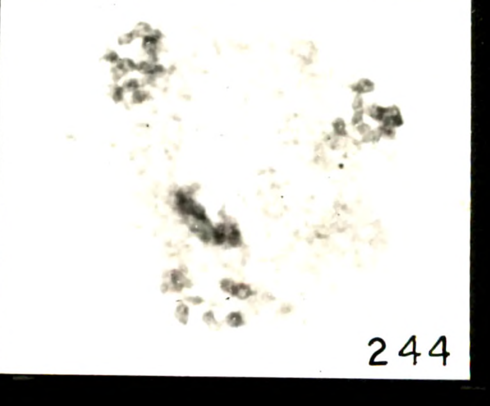
244

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Solanum trilobatum

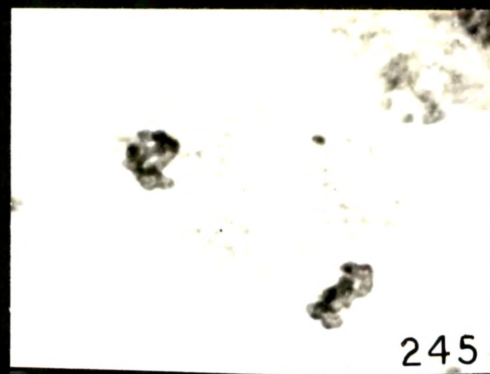
Coll. No. 10 (Contd.) :

(Meiosis)

Fig. 245 - PMC showing laggard at telophase I.

Coll. No. 48 :

Fig. 246 -	"	"	12 bivalents at diakinesis (early).
Fig. 247 -	"	"	12 bivalents along with few interbivalent connections at diakinesis (late).
Figs.248 and 249 -	PMCs	"	metaphase I (Polar view).
Fig. 251 -	PMC	"	telophase I.
Fig. 250 -	"	"	metaphase II.



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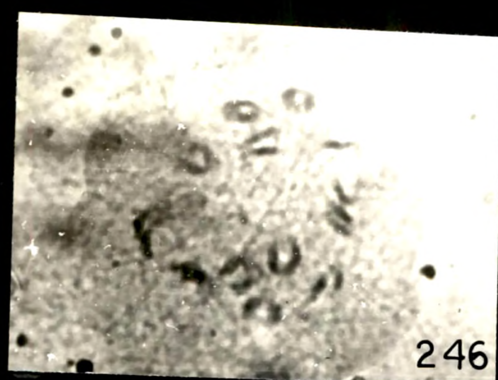

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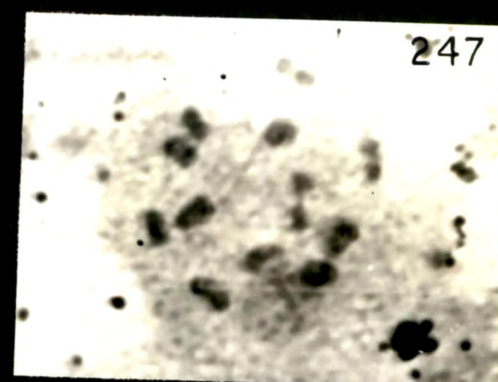

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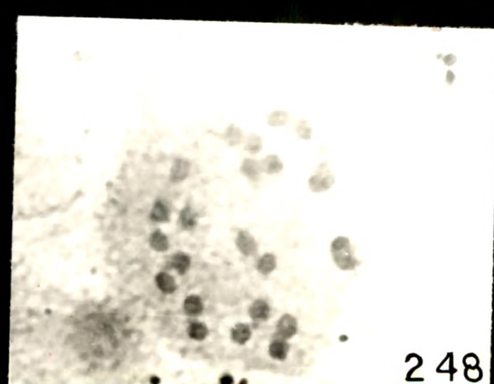

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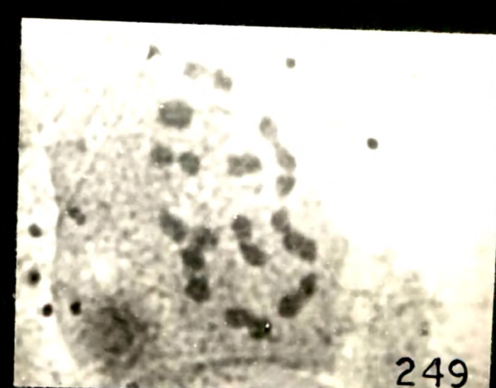

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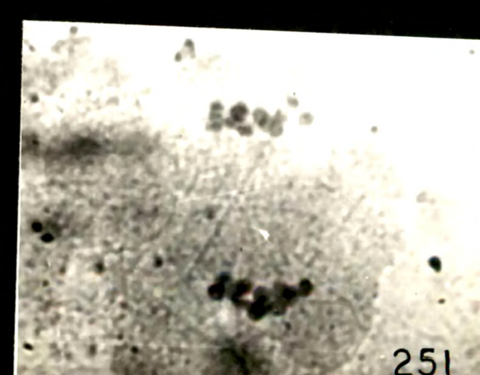
250



251

PL. 2 : 53

in the earlier work.

The collected populations did not show, between the two, striking morphological differences. Therefore, observed structural differences in the karyotypes indicate the presence of two cytotypes within the species.

Regular behaviour of chromosomes is observed in majority of the PMCs. 12 distinct bivalents are observed at early and late diakinesis (Figs. 241, 242 and 246, 247) and equal distribution of the same is noticed in subsequent stages (Figs. 243 & 251). Abnormalities observed in few PMCs are : interbivalent connections at diakinesis resulting in grouping of bivalents at diakinesis (Figs. 241, 242, 247), presence of non congressional bivalents (Fig. 252) early separation of one bivalent (Fig. 253) at metaphase I, laggards at telophase I (Fig. 245) and non synchronised movement of metaphase plates and abnormal orientation during second meiotic division (Fig. 244).

Solanum heterodoxum Dunal

Earlier reports of Vilmorin & Simonet (1928), Jörgensen (1928), Delay (1947) and Gottschalk (1954) for the species are 2n = 24. The population of this species studied showed n = 12 and 2n = 24.

Coll. No. 34 :

Karyotype formula : $2n = 24 = C_4+D_2^S+D_6+F_2^S+F_6+H_4$

(Table 2:39)

The chromosomes of the complement are medium to short sized ranging in length from 1.531 to 3.513 μ having mean length 1.23 μ. Of the 12 pairs, 8 pairs (C, F & H-types) are with nearly submedian and remaining 4 pairs (D-type) are with nearly median centromeres. Both chromosome pairs having satellites are equal in length i.e. 2.207 μ. However, one pair of satellited chromosome i.e. D-type is having nearly median centromere while the other pair F-type is having nearly submedian centromere. Above mentioned details point towards the asymmetrical nature of the karyotype. The calculated values of L/S ratio (2.29) and TF% (35.37%) confirm the same. The idiogram also shows the asymmetrical and graded nature having abrupt gradation at certain points (Figs. 254, 255 & 256).

On the whole meiosis is regular and 12 bivalents are noticed at early and late diakinesis (Figs. 257, 258) and at metaphase I (Fig. 259). In few PMCs persistent nucleolus is observed even at late diakinesis. But for the observation of grouping of bivalents (Fig. 260) at diakinesis and early separation of few bivalents (Fig. 259) at metaphase I, no other abnormality is observed in PMCs. The second meiotic division is normal (Fig. 261). The determined pollen fertility for the taxon is 97.78%.

Pl. 2: 54

Solanum trilobatum

Coll. No. 48 :

(Meiosis)

Fig. 252 - PMC showing non congressional bivalents at metaphase I.

Fig. 253 - " " early separation of one bivalent at metaphase I.

Solanum heterodoxum

Coll. No. 34 :

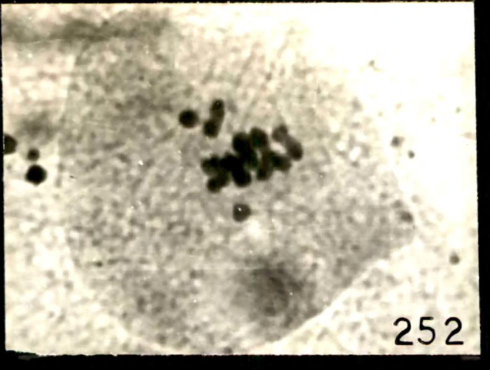
(Mitosis)

Fig. 254 - Camera lucida drawing of the somatic metaphase plate.

Fig. 255 - Photomicrograph of the same.

Fig. 256 - Idiogram.

Contd...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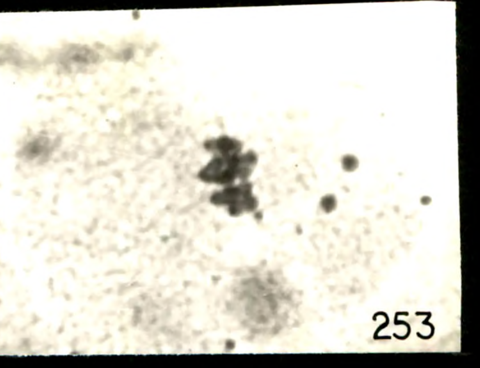
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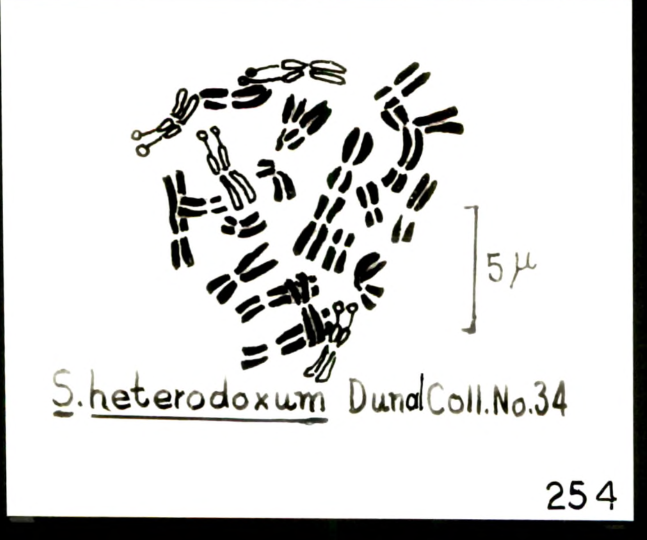

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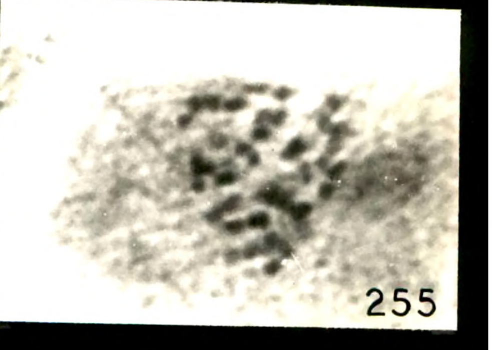
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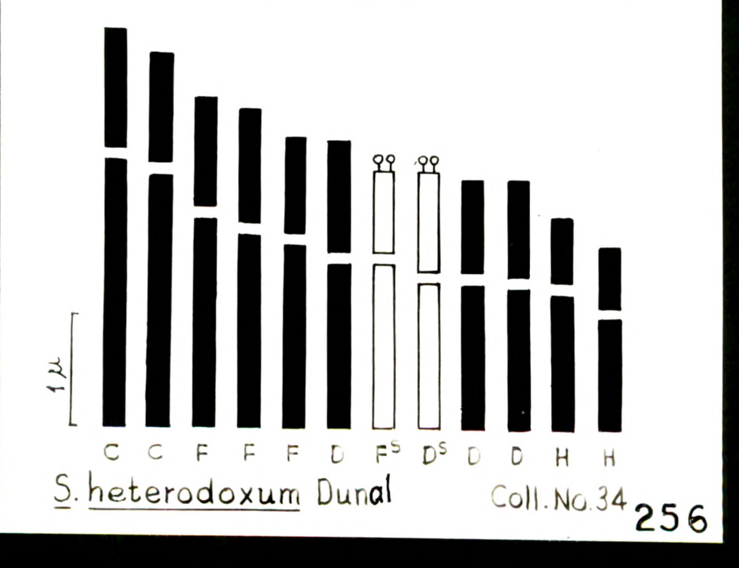


256

PL. 2 : 54

Pl. 2: 55

Solanum heterodoxum

Coll. No. 34 (Contd.) :

(Meiosis)

Fig. 257 - PMC showing 12 bivalents at diakinesis.

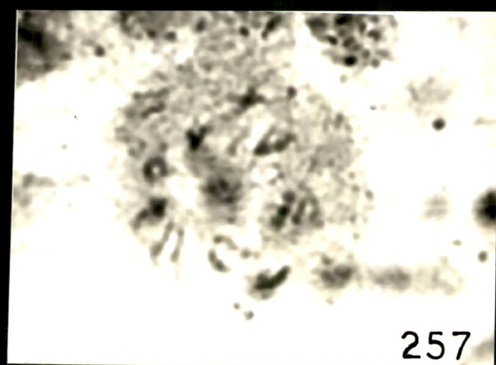
Fig. 258 - " " 11 bivalents and 2 univalents at diakinesis.

Fig. 260 - " " groupings of bivalents at diakines.

$^{1}(III)^{+2}(II)^{+4}(I)^{+2}$ univalents.

Fig. 259 - " " early separation of few bivalents at metaphase I.

Fig. 261 - " " duplicated chromosomes during second meiotic division (Polar view).



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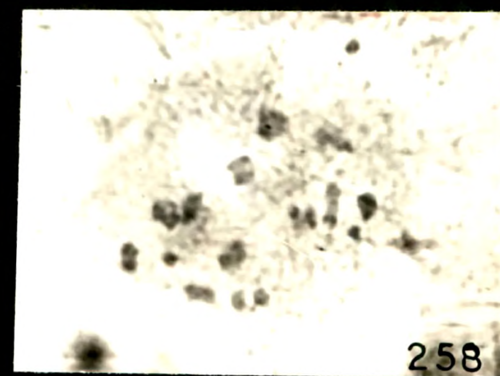

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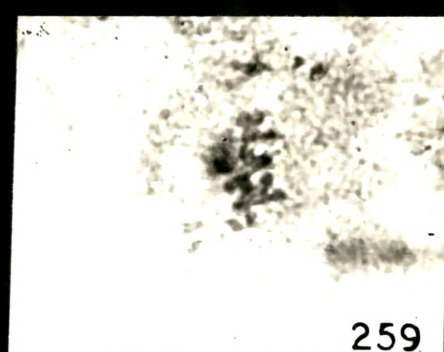

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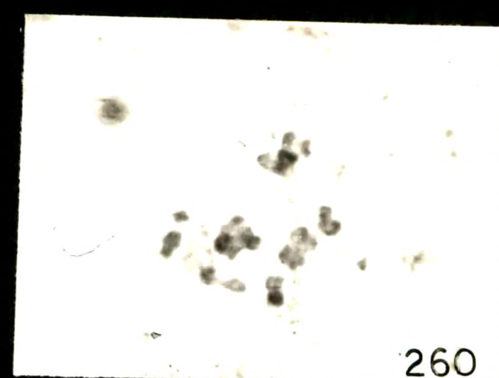

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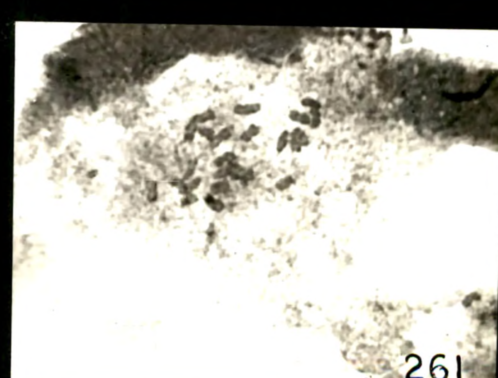

261

PL. 2 : 55

Table 2:39. Details of the karyotype analysis of Solanum heterodoxum Dun. (Coll. No. 34).

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm +	Short Arm =	Total length	R_1	R_2			
1, 2	2.432 +	1.081 =	3.513	0.44	2.24	100	nsm	C
3, 4	2.297 +	0.991 =	3.288	0.43	2.31	93	nsm	C
5, 6	1.891 +	0.991 =	2.882	0.52	1.90	82	nsm	F
7, 8	1.756 +	1.036 =	2.792	0.58	1.69	79	nsm	F
9,10	1.666 +	0.856 =	2.522	0.51	1.94	71	nsm	F
11,12	1.486 +	0.991 =	2.477	0.66	1.49	70	nm	D
13,14	1.486 +	0.721 =	2.207	0.48	2.06	62	nsm	F^S
15,16	1.306 +	0.901 =	2.207	0.68	1.44	62	nm	D^S
17,18	1.306 +	0.856 =	2.162	0.65	1.52	61	nm	D
19,20	1.261 +	0.901 =	2.162	0.71	1.39	61	nm	D
21,22	1.216 +	0.585 =	1.801	0.51	2.07	51	nsm	H
23,24	0.991 +	0.540 =	1.531	0.54	1.83	43	nsm	H
	19.094	10.450	29.544					

L/S = 2.29

Mean length = 1.23 μ

T F % = 35.37 %

Karyotype formula = 2n = 24 = $C_4 + D_2^S + D_6 + F_2^S + F_6 + H_4$

F A B A C E A E

The categorisation adopted for the members of Fabaceae is as follows :

1. Long chromosome - 5 μ or more in length

    1.1 With nearly submedian centromere .... A

2. Long chromosome - 4 μ to less than 5 μ in length

    2.1 With nearly median centromere .... B

    2.2 With nearly submedian centromere C

3. Medium chromosome - 3 μ to less than 4 μ in length

    3.1 With nearly median centromere .... D

    3.2 With submedian centromere .... E

    3.3 With nearly submedian centromere .... F

4. Medium chromosome - 2 μ to less than 3 μ in length

    4.1 With nearly median centromere .... G

    4.2 With nearly submedian centromere .... H

5. Short chromosome - less than 2 μ in length

    5.1 With nearly median centromere I

    5.2 With nearly submedian centromere .... J

    5.3 With submedian centromere .... K

<u>Superscript</u>

S - denotes satellited chromosome

S' - denotes chromosome with secondary constriction on long arms.

S" - denotes chromosome with secondary constriction on short arms.

FABACEAE

Tephrosia Pers.

Tephrosia strigosa Dalz.

Chromosome number reports, both n and 2n, for various species of Tephrosia are available in literature. But no report about this species could be traced from the available literature. In present study n = 11 and 2n = 22 chromosomes are encountered.

Coll. No. 63 :

Karyotype formula : $2n = 22 = G_6+H_8+I_4+J_4$

(Table 2:40)

Karyotypic analysis of the somatic complement reveals the presence of 2n = 22 chromosomes. The complement contains only medium sized (2.026 to 2.522 μ) and short sized (1.531-1.891 μ) chromosomes. The position of centromere is nearly median for 5 pairs distributed in G & I-types while the remaining 6 pairs are with nearly submedian centromeres distributed in H & J-types. Noteworthy features of the karyotype of this species are: total absence of satellited or secondarily constricted chromosomes and in its having comparatively short sized chromosomes with mean length of 1.01 μ. The less asymmetrical and smooth gradation of the karyotype is evident by the calculated values

Table 2:40. Details of the karyotype analysis of *Tephrosia strigosa* Dalz. (Coll. No. 63).

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.621	+ 0.901	= 2.522	0.55	1.79	100	nsm	H
3, 4	1.576	+ 0.676	= 2.252	0.42	2.33	89	nsm	H
5, 6	1.351	+ 0.901	= 2.252	0.66	1.49	89	nm	G
7, 8	1.441	+ 0.721	= 2.162	0.50	1.99	85	nsm	H
9,10	1.396	+ 0.721	= 2.117	0.51	1.93	83	nsm	H
11,12	1.261	+ 0.810	= 2.071	0.64	1.55	82	nm	G
13,14	1.216	+ 0.810	= 2.026	0.66	1.50	80	nm	G
15,16	1.306	+ 0.585	= 1.891	0.44	2.23	74	nsm	J
17,18	1.171	+ 0.540	= 1.711	0.46	2.16	67	nsm	J
19,20	1.035	+ 0.676	= 1.711	0.65	1.53	67	nm	I
21,22	0.946	+ 0.585	= 1.531	0.61	1.61	60	nm	I
	14.320	7.926	22.246					

L/S = 1.64

Mean length = 1.01 μ

T F % = 35.62 %

Karyotype formula = 2n = 22 = $G_6 + H_8 + J_4 + I_4$

Pl. 2: 56

Tephrosia strigosa

Coll. No. 63 :

(Mitosis)

Fig. 262 - Camera lucida drawing of somatic metaphase plate.

Fig. 263 - Idiogram.

Fig. 264 - Photomicrograph of somatic metaphase plate.

(Meiosis)

Fig. 265 - Camera lucida drawing of PMC showing 11 bivalents at diakinesis (late).

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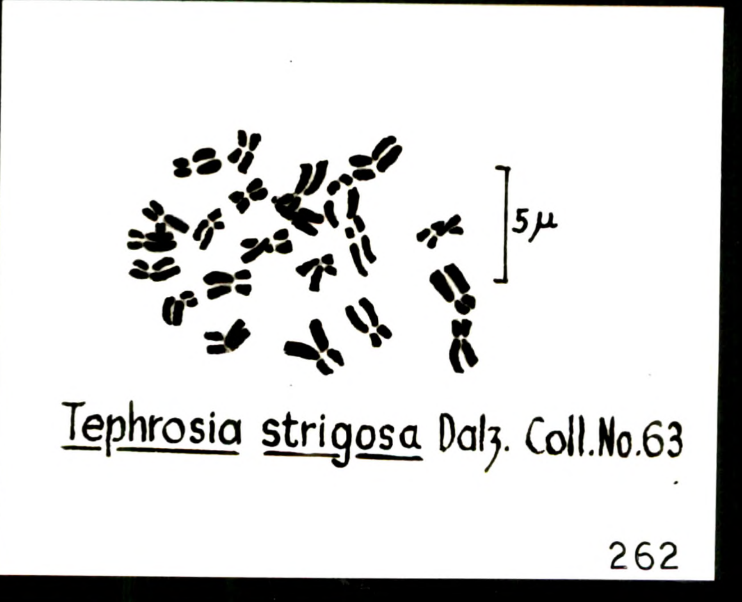
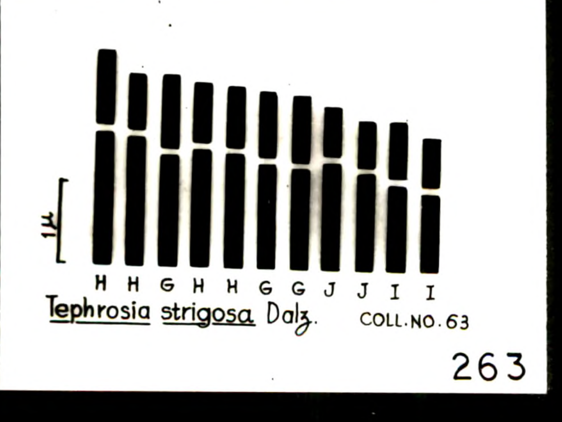


262



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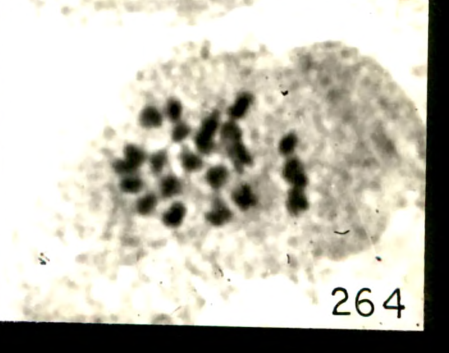

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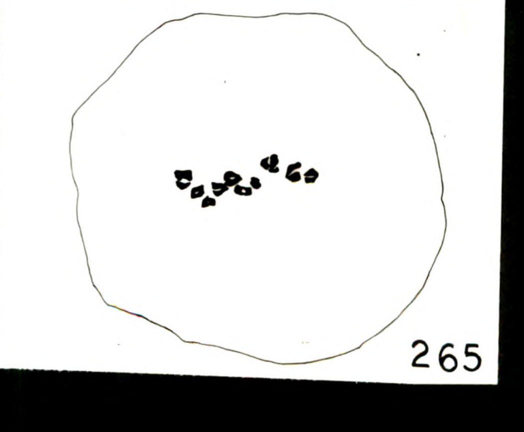

265

PL. 2 : 56

of relative length of all the pairs of the complement and the determined value of L/S ratio (1.64). However, the asymmetry of the karyotype, inherent in the species of Tephrosia studied, is also evident in the idiogram & TF% (35.62%) of the taxon (Figs. 262, 263, 264).

PMCs analysed for meiotic behaviour of chromosomes, showed the presence of 11 distinct bivalents at diakinesis (Fig. 265) and their equal distribution at telophase I (Fig. 267). In late diakinesis particularly the 2 bivalents are close together and look like quadrivalent. But the distinctness of the two associated bivalents is clear from their morphology (Fig. 266). The meiosis in general is regular and no abnormality is observed at any stage. The pollen fertility determined for the species is 96.61%.

Tephrosia jamnagarensis Santapau

The plant is of rare occurrence and was collected from Surat growing as a weed in the fields.

Cytology of this taxon for n and 2n numbers, karyotype and meiotic behaviour is studied for the first time. Like many other species of *Tephrosia*, this also revealed the presence of n = 11 and 2n = 22.

Coll. No. 64 :

Karyotype formula : $2n = 22+ 2B = F_4+G_2^S+G_6+H_8+J_2$

(Table 2:41)

Table 2:41. Details of the karyotype analysis of <u>Tephrosia jamnagarensis</u> Santapau (Coll. No. 64).

Chromosome pair	Length in μ: Long Arm	+	Short Arm	=	Total length	Arm Ratios: R_1	R_2	Relative length	Centromere	Type
1, 2	2.762	+	1.223	=	3.985	0.44	2.25	100	nsm	F
3, 4	2.170	+	0.868	=	3.038	0.40	2.50	76	nsm	F
5, 6	1.815	+	0.750	=	2.565	0.41	2.42	64	nsm	H
7, 8	1.697	+	0.868	=	2.565	0.51	1.95	64	nsm	H
9,10	1.697	+	0.789	=	2.486	0.46	2.15	62	nsm	H
11,12	1.381	+	1.026	=	2.407	0.74	1.34	60	nm	G^S
13,14	1.381	+	0.987	=	2.368	0.71	1.39	59	nm	G
15,16	1.342	+	0.789	=	2.131	0.58	1.70	53	nsm	H
17,18	1.144	+	0.987	=	2.131	0.86	1.15	53	nm	G
19,20	1.263	+	0.789	=	2.052	0.62	1.60	51	nm	G
21,22	1.144	+	0.631	=	1.775	0.55	1.81	44	nsm	J
	17.796		9.707		27.503					

L/S = 2.24

Mean length = 1.25 μ

T F % = 35.29%

Karyotype formula = 2n = $22\angle^{+2B} = F_4 + G_2^S + G_6 + H_8 + J_2$

Pl. 2: 57

Tephrosia strigosa

Coll. No. 63 (Contd.) :

(Meiosis)

Fig. 266 - PMC at diakinesis showing 2 bivalents very close to each other.

Fig. 267 - PMC showing equal distribution of chromosomes at telophase I.

Tephrosia jamnagarensis

Coll. No. 64 :

(Mitosis)

Fig. 268 - Camera lucida drawing of somatic metaphase plate.

Fig. 269 - Idiogram.

Fig. 270 - Photomicrograph of somatic metaphase plate.

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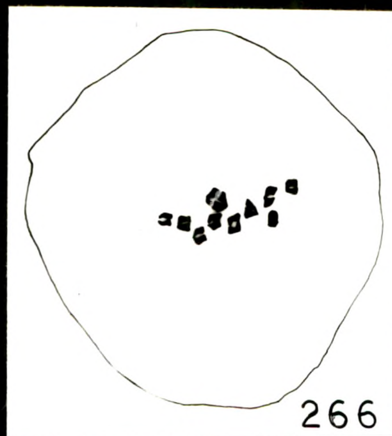

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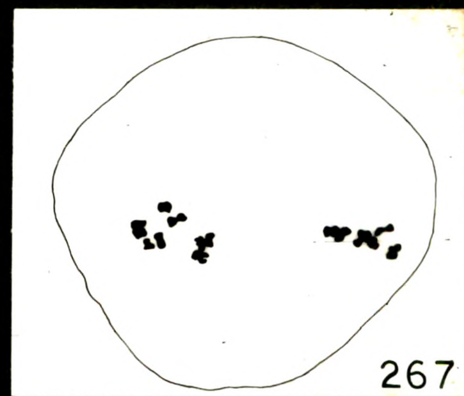

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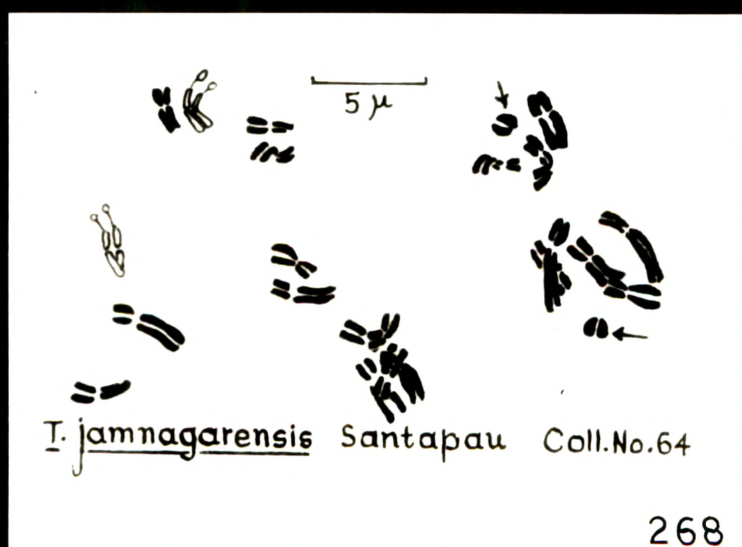

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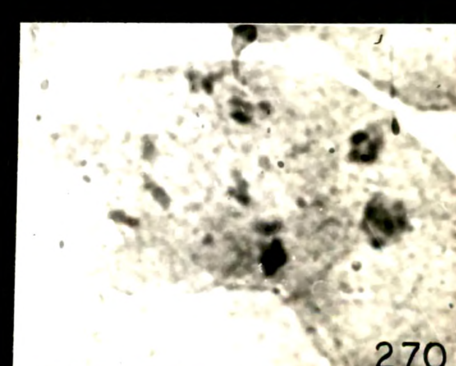


270

PL. 2 : 57

Pl. 2:58

Tephrosia jamnagarensis

Coll. No. 64 (Contd.) :

(Meiosis)

Fig. 271 - PMC showing 11 bivalents at diakinesis.

Fig. 272 - " " 11 " " metaphase I.

Fig. 273 - " " equal distribution of chromosomes at anaphase I.

Fig. 274 - " " isobilateral tetrad formation.

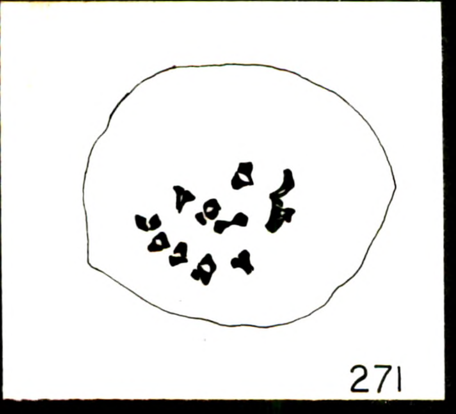
Tephrosia uniflora subsp. petrosa

Coll. No. 65 :

(Mitosis)

Fig. 275 - Camera lucida drawing of somatic metaphase plate.

Contd...



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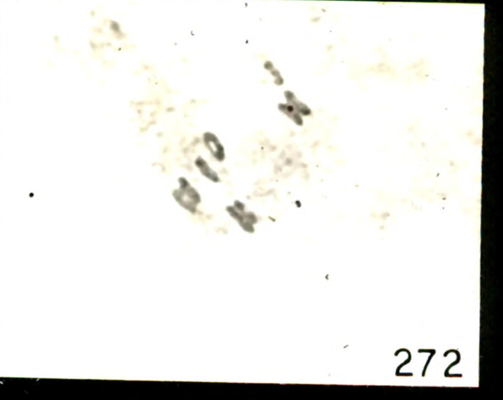

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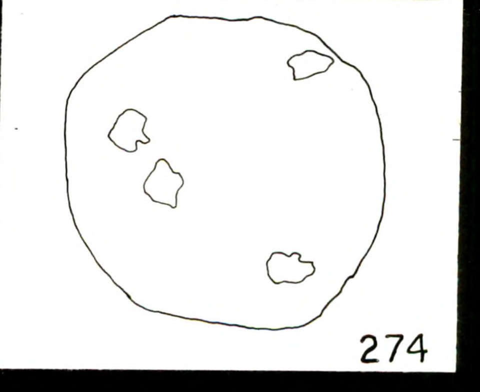
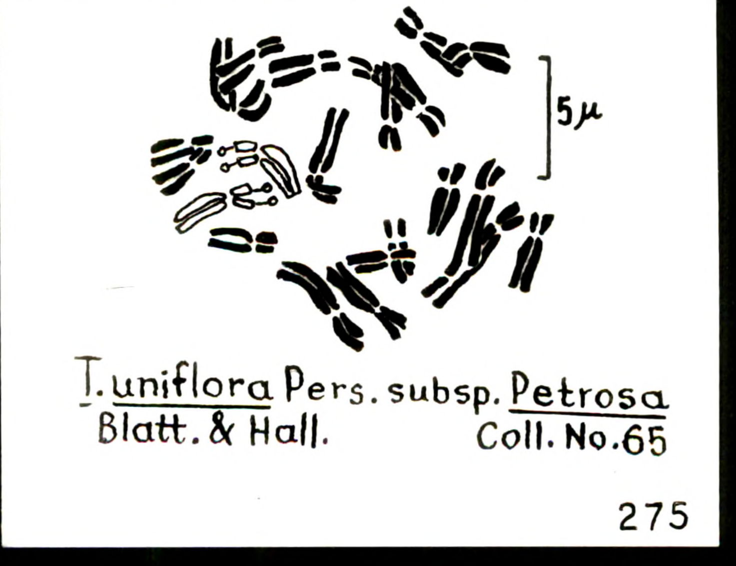


274



275

PL. 2 : 58

The somatic complement has 10 pairs of medium sized 2.052 to 3.985 μ, of F, G & H-types and one pair of short sized, 1.775 μ, of J-type chromosomes. In addition 2 darkly stained bodies representing B-chromosomes, are also noticed. The position of the centromere is nearly submedian in 7 pairs and nearly median in 4 pairs of chromosomes. Among the 4 pairs with nearly median centromeres, one pair is satellited (G^S-type). The mean length of the chromosome in the complement is 1.25 μ. However, higher values of TF% (35.29%) and L/S ratio (2.24) indicate the asymmetrical and abruptly graded nature of the karyotype (Figs. 268, 269 and 270).

In this species of Tephrosia analysed pollen mother cells show regular behaviour of meiotic chromosomes. 11 bivalents are observed at diakinesis (Fig. 271), metaphase I (Fig. 272) and their equal distribution at anaphase I (Fig. 273). During second meiotic division regular behaviour shows formation of regular tetrads (Fig. 274). Presence of B-chromosomes in the somatic complement is also substantiated by observed small but darkly stained bodies in few PMCs (Fig. 271). Except for the grouping of bivalents at metaphase I (Fig. 272) no other abnormality is observed in meiotic study of this taxon. The pollen fertility for the species is 98.89%.

Tephrosia uniflora Pers. subsp. petrosa Blatt. & Hall.

The present study confirms the earlier report of 2n = 22 by Miege (1961) and n = 11 by Sanjappa & Bhatt (1976). However, no reference regarding the detailed karyotypic study and meiotic behaviour could be traced from the available literature.

Coll. No. 65 :

Karyotype formula : $2n = 22 = A_2+C_2+F^S_2+F_6+G_4+H_6$

(Table 2:42)

The somatic metaphase plate shows the presence of 2 pairs of long chromosomes (A & C-types) and 9 pairs of medium sized chromosomes. But for 2 pairs of G-type having nearly median centromere all the rest are with nearly submedian centromeres. No chromosome pair with secondary constriction on long arm or short arm, is noticed in the complement. The satellited chromosomes are represented by a pair belonging to F^S-type. The longest pair is 5.134 μ in length while the shortest one is 2.477 μ. The mean length of the chromosomes within the karyotype is 1.68 μ. The higher value of L/S ratio i.e. 2.07 is reflected in abrupt gradation of the idiogram. The TF% determined for the species is 32.24%. Therefore, the karyotype be considered slightly less asymmetrical than preceding one (Figs. 275, 276, 277).

The somatic complement number 2n = 22 is confirmed by the observation of 11 bivalents at diakinesis (Figs. 278 & 279) and metaphase I (Fig. 280). Few PMCs showed early separation

Pl. 2: 59

Tephrosia uniflora subsp. petrosa

Coll. No. 65 (Contd.) :

(Mitosis)

Fig. 276 - Idiogram.

Fig. 277 - Photomicrograph of somatic metaphase plate.

(Meiosis)

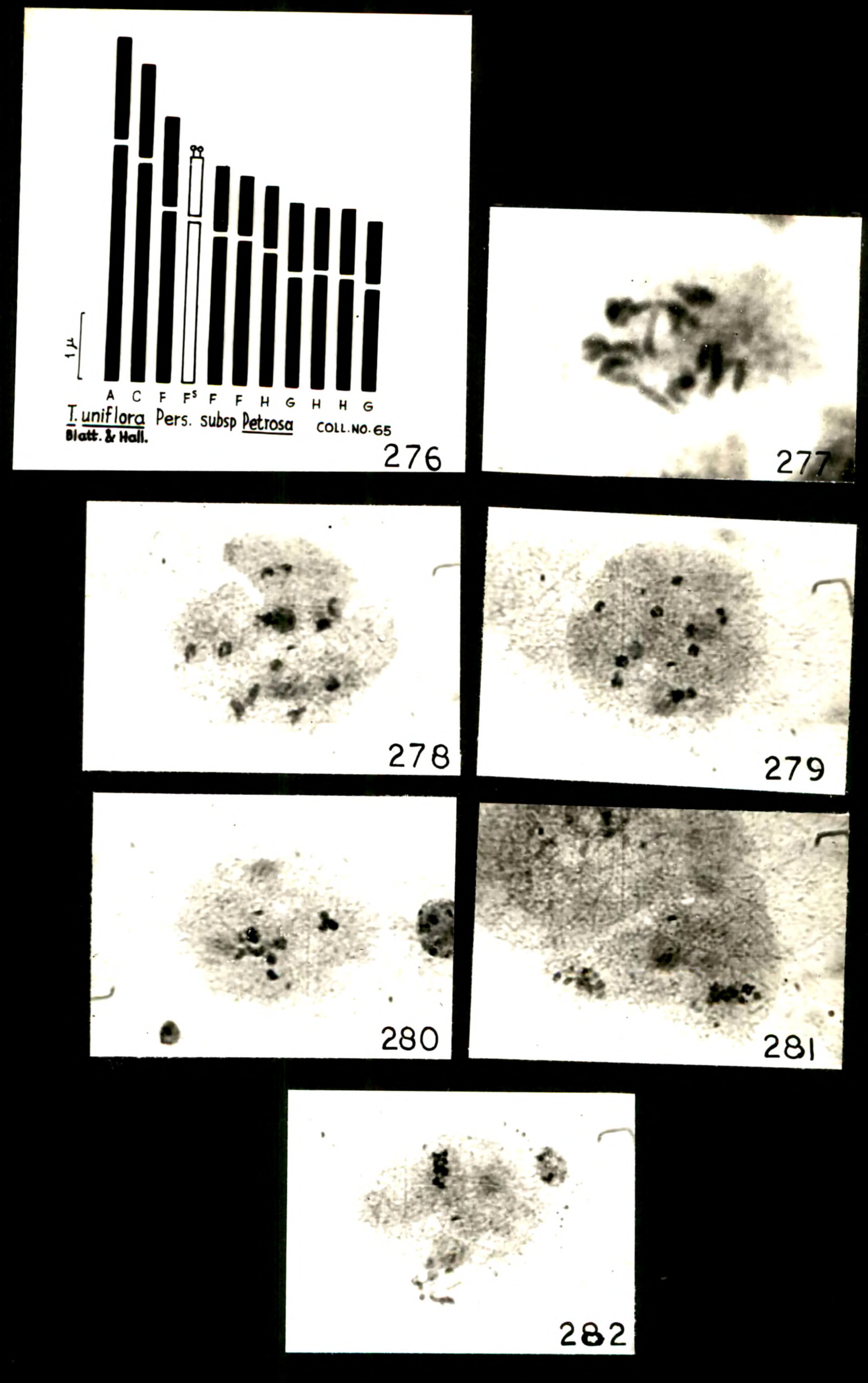
Fig. 278 - PMC showing 11 bivalents, along with nucleolus at diakinesis.

Fig. 279 - " " 11 bivalents along with 3 nucleoli at diakinesis.

Fig. 280 - " " groupings of bivalents at metaphase I ($^{1}(VIII)^{+1}(III)$)

Fig. 281 - " " metaphase II.

Fig. 282 - " " non synchronised movement of chromosomes during second meiotic division.


1 μ
A C F F^s F F H G H H G
T. uniflora Pers. subsp Petrosa
Blatt. & Hall.
COLL. NO. 65
276
277
278
279
280
281
282

PL. 2 : 59

Table 2:42. Details of the karyotype analysis of <u>Tephrosia uniflora</u> Pers. subsp. <u>petrosa</u> (Blatt. & Hall.) (Coll. No. 65).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	3.603	+	1.531	=	5.134	0.42	2.35	100	nsm	A
3, 4	3.332	+	1.396	=	4.728	0.41	2.38	92	nsm	C
5, 6	2.612	+	1.351	=	3.963	0.51	1.93	77	nsm	F
7, 8	2.477	+	0.901	=	3.378	0.36	2.74	65	nsm	F^S
9,10	2.252	+	0.991	=	3.243	0.44	2.27	63	nsm	F
11,12	2.206	+	0.901	=	3.107	0.48	2.44	60	nsm	F
13,14	2.026	+	0.946	=	2.972	0.46	2.14	57	nsm	H
15,16	1.666	+	1.036	=	2.702	0.62	1.60	52	nm	G
17,18	1.711	+	0.946	=	2.657	0.55	1.80	51	nsm	H
19,20	1.666	+	0.991	=	2.657	0.59	1.68	51	nsm	H
21,22	1.531	+	0.946	=	2.477	0.62	1.61	48	nm	G
	25.082		11.936		37.018					

L/S = 2.07

Mean length = 1.68 μ

T F % = 32.24 %

Karyotype formula = $2n = 22 = A_2 + C_2 + F^S_2 + F_6 + G_4 + H_6$

of one bivalent at diakinesis (Fig. 278). During second meiotic division non synchronised movement of chromosomes is noticed (Fig. 282). Secondary association of bivalents resulting in the formation of 2 groups of 8 and 3 bivalents respectively (Fig. 280) is observed in rare cases. Variable number of nucleoli are observed at diakinesis (Figs. 278,279). 98.07% pollen fertility is determined for the taxon.

<u>Tephrosia subtriflora</u> Hochst.

As far as it could be ascertained from the available literature, no report of the chromosome number or detailed cytological study, for the taxon is available. This therefore, is the first report of both n and 2n numbers. The karyotypic analysis also been attempted for the first time.

<u>Coll. No. 66</u> :

Karyotype formula : $2n = 22 = B_2 + F_2^{S''} + F_2 + H_2^{S} + H_{10} + J_4$

(Table 2:43)

The observation of 2n = 22, chromosomes for the species is in full agreement with the other species of the genus <u>Tephrosia</u>. The chromosome complement has only one pair of long chromosomes (B-type) with nearly submedian centromere. While remaining 10 pairs are with nearly submedian centromeres. Chromosomes with submedian centromeres are represented by 2 pairs of F-type, 6 pairs of H-type and 2 pairs of J-type.

Table 2:43. Details of the karyotype analysis of <u>Tephrosia subtriflora</u> Hochst. (Coll. No. 66).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.526	+	1.736	=	4.262	0.68	1.45	100	nm	B
3, 4	2.526	+	1.342	=	3.868	0.53	1.88	90	nsm	F
5, 6	1.973	+	0.552 / 0.513	=	3.038	0.53	1.85	71	nsm	$F^{S''}$
7, 8	2.131	+	0.750	=	2.881	0.35	2.84	67	nsm	H^S
9,10	1.934	+	0.947	=	2.881	0.48	2.04	67	nsm	H
11,12	1.973	+	0.829	=	2.802	0.42	2.37	65	nsm	H
13,14	1.697	+	0.986	=	2.683	0.58	1.72	62	nsm	H
15,16	1.815	+	0.829	=	2.644	0.45	2.18	62	nsm	H
17,18	1.381	+	0.710	=	2.091	0.51	1.94	49	nsm	H
19,20	1.263	+	0.592	=	1.855	0.46	2.13	43	nsm	J
21,22	1.065	+	0.592	=	1.657	0.55	1.79	38	nsm	J
	20.284		10.378		30.662					

L/S = 2.57

Mean length = 1.39 μ

T F % = 33.84 %

Karyotype formula = $2n = 22 = B_2 + F_2^{S''} + F_2 + H_2^S + H_{10} + J_4$

Pl. 2: 60

Tephrosia subtriflora

Coll. No. 66 :

(Mitosis)

Fig. 283 - Camera lucida drawing of somatic metaphase plate.

Fig. 284 - Idiogram.

Fig. 285 - Photomicrograph of somatic metaphase plate.

(Meiosis)

Fig. 286 - PMC showing 11 bivalents at metaphase I.

Fig. 287 - " " groupings of bivalents at metaphase I.

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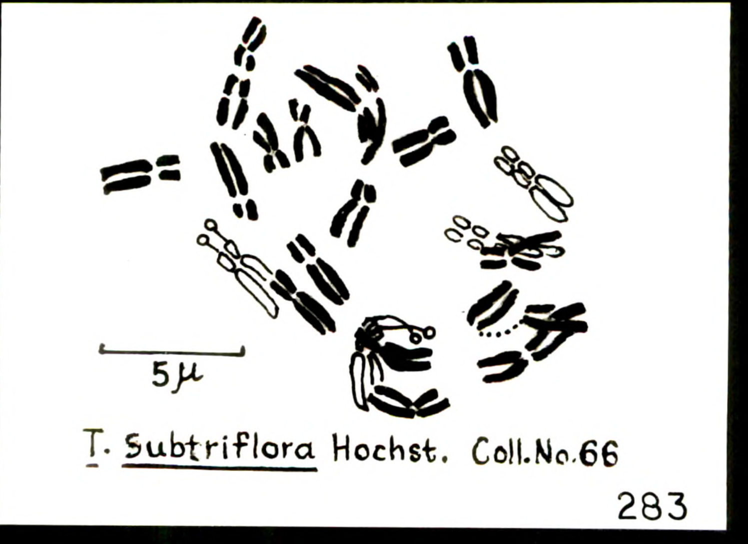

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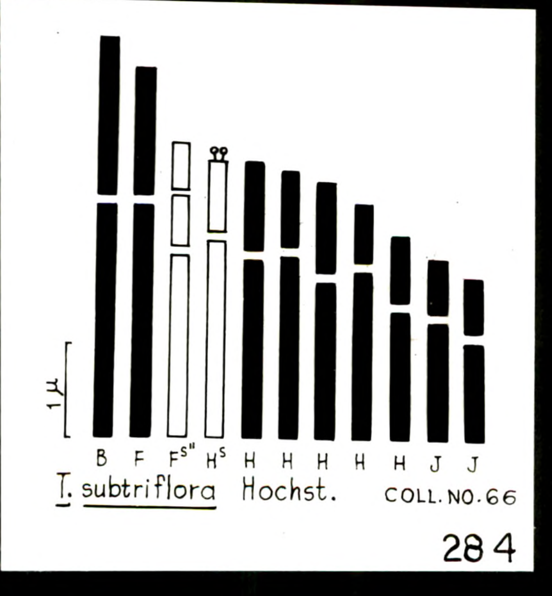

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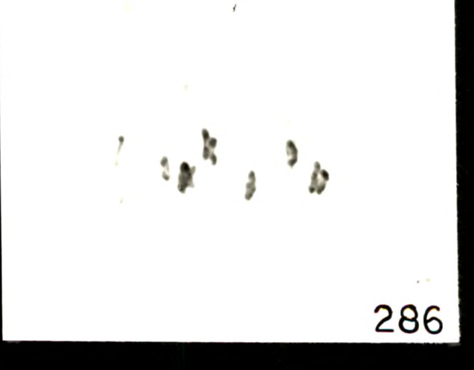

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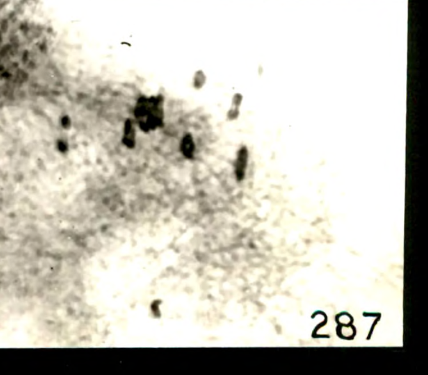

287

PL. 2 : 60

Pl. 2:61

Tephrosia subtriflora

Coll. No. 66 (Contd.) :

(Meiosis)

Fig. 288 - PMC showing groupings of bivalents at metaphase I. ($1_V + 1_{IV} + 2_I$)

Fig. 289 - " " non synchronised movement of chromosomes during second meiotic division.

Fig. 290 - " " telophase II.

Fig. 291 - " " 2 laggards at telophase II.

Tephrosia villosa

Coll. No. 20 : (Mitosis)

Fig. 292 - Camera lucida drawing of somatic metaphase plate.

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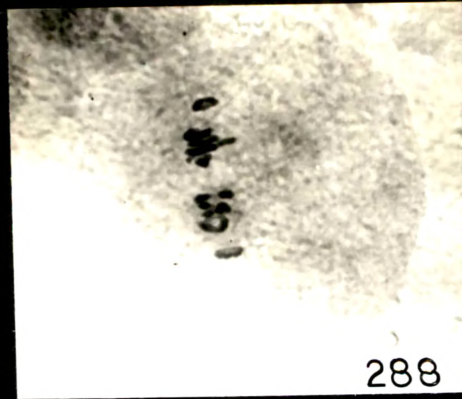
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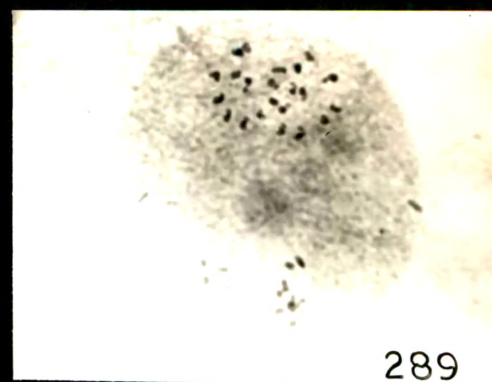
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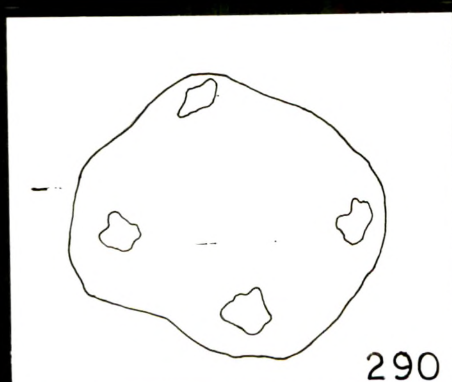
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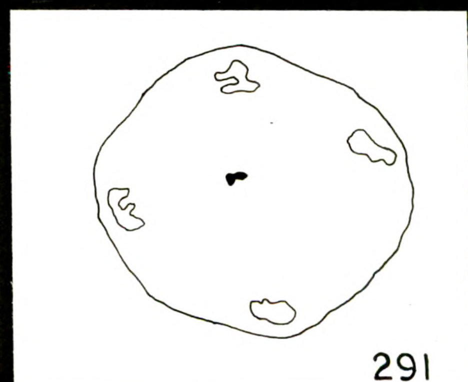
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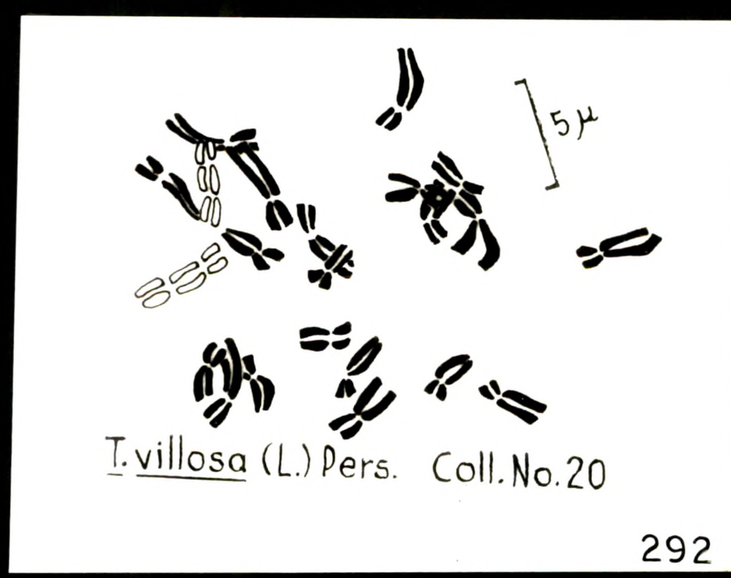

292

PL. 2 : 61

Secondarily constricted and satellited chromosomes are represented by a pair each and they belong to $F^{S''}$ and H^{S}-types, respectively. Within the karyotype chromosome length ranges between 1.657 to 4.262 μ, having a mean length of 1.393 μ. The TF% is 33.84% and L/S ratio is 2.57. These values and idiogram, determined for the species, indicate asymmetrical nature of the karyotype, with abrupt gradation (Figs. 283, 284, 285).

Meiotic study revealed the presence of 11 bivalents at metaphase I (Fig. 286). In few pollen mother cells, various types of groupings of bivalents are noticed at metaphase I (Figs. 287, 288). Abnormalities such as, grouping and occurrence of non congressional bivalents at metaphase I and laggards at telophase II (Fig. 291) are observed in few PMCs only. Very rarely non-synchronised movement during II meiotic division is noticed (Fig. 289). In most of the PMCs at the end of second meiotic division normal tetrad formation takes place (Fig. 290). Pollen fertility determined for the species is 95.97%.

<u>Tephrosia villosa</u> (L.) Pers.

The earlier reports of 2n = 22 for the somatic complement of the taxon by Frahm-Leliveld (1953), Krishnappa & Basavaraj (1978) and haploid chromosome number n = 11 by Sanjappa & Bhatt (1976) are confirmed by the present study. However, the detailed karyotypic analysis of the 3 populations studied revealed the presence of minor structural differences among them.

Coll. No. 20 :

Karyotype formula : $2n = 22 = C_6 + F_2^{S'} + F_4 + G_2 + H_8$

(Table 2:44)

The karyotype contains 10 pairs of chromosomes with nearly submedian (C, F & H-types) and only one pair with nearly median (G-type) centromeres. Among the chromosomes with nearly submedian centromeres, 3 pairs are comparatively long (C-type) while remaining 7 pairs are medium sized, distributed in F & H-types. One pair of F-type of chromosome is having secondary constrictions on its long arms ($F^{S'}$-type). The determined values for the absolute length, mean length and L/S ratio are 36.696 μ, 1.67 μ and 1.91 respectively. The lesser value of TF% i.e. 32.02% and idiogram depict the asymmetrical nature of the karyotype (Figs. 292, 293, 294).

Coll. No. 52 :

Karyotype formula : $2n = 22 + 2B = F_2 + G_6 + H_2^S + H_6 + J_4$

(Table 2:45)

The somatic complement of this collection differs from the other two in having 2 accessory chromosomes (B-chromosomes).

Table 2:44. Details of the karyotype analysis of <u>Tephrosia villosa</u> (L.) Pers. (Coll. No. 20)

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm	+ Short Arm	= Total length	R_1	R_2			
1, 2	2.920	+ 1.381	= 4.301	0.47	2.11	100	nsm	C
3, 4	2.881	+ 1.183	= 4.064	0.41	2.43	94	nsm	C
5, 6	3.117	+ 0.908	= 4.025	0.29	3.43	93	nsm	C
7, 8	2.525	+ 1.421	= 3.946	0.56	1.77	91	nsm	F
9,10	1.026 + 1.381	+ 1.381	= 3.788	0.57	1.74	88	nsm	$F^{S'}$
11,12	2.367	+ 0.829	= 3.196	0.35	2.85	74	nsm	F
13,14	1.894	+ 1.105	= 2.999	0.58	1.71	69	nsm	H
15,16	1.973	+ 0.907	= 2.880	0.45	2.17	66	nsm	H
17,18	1.618	+ 1.065	= 2.683	0.65	1.51	62	nm	G
19,20	1.776	+ 0.789	= 2.565	0.44	2.25	59	nsm	H
21,22	1.460	+ 0.789	= 2.249	0.54	1.85	52	nsm	H
	24.938	11.758	36.696					

L/S = 1.91
Mean length = 1.67 μ
T F % = 32.02 %
Karyotype formula = 2n = 22 = $C_6 + F_2^{S'} + F_4 + G_2 + H_8$

Table 2:45. Details of the karyotype analysis of <u>Tephrosia villosa</u> (L.) Pers. (Coll. No. 52).

Chromosome pair	Length in u					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.368	+	0.908	=	3.276	0.38	2.60	100	nsm	F
3, 4	0.908 + 1.183	+	0.908	=	2.999	0.43	2.30	91	nsm	$H^{S'}$
5, 6	1.854	+	0.868	=	2.722	0.46	2.13	83	nsm	H
7, 8	1.776	+	0.868	=	2.644	0.48	2.04	80	nsm	H
9,10	1.539	+	0.986	=	2.525	0.64	1.56	77	nm	G
11,12	1.421	+	0.868	=	2.289	0.61	1.63	69	nm	G
13,14	1.421	+	0.868	=	2.289	0.61	1.63	69	nm	G
15,16	1.381	+	0.789	=	2.170	0.57	1.75	66	nsm	H^S
17,18	1.381	+	0.789	=	2.170	0.57	1.75	66	nsm	H
19,20	1.263	+	0.710	=	1.973	0.56	1.77	60	nsm	J
21,22	1.263	+	0.710	=	1.973	0.56	1.77	60	nsm	J
	17.758		9.272		27.030					

L/S = 1.66

T F % = 34.30 %

Mean length = 1.22 u

Karyotype formula = 2n = 22 + 2B = $F_2 + G_6 + H_2^{S'} + H_2^{S} + H_6 + J_4$

Pl. 2: 62

Tephrosia villosa

Coll. No. 20 (Contd.):

(Mitosis)

Fig. 293 - Idiogram.

Fig. 294 - Photomicrograph of somatic metaphase plate.

Coll. No. 52 :

Fig. 295 - Camera lucida drawing of somatic metaphase plate.

Fig. 296 - Photomicrograph of the same.

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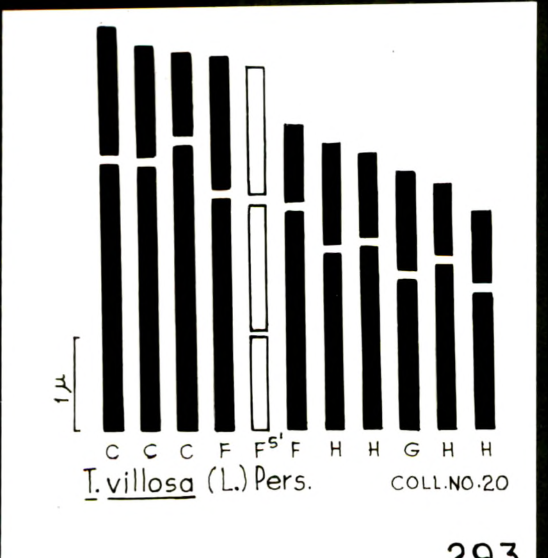

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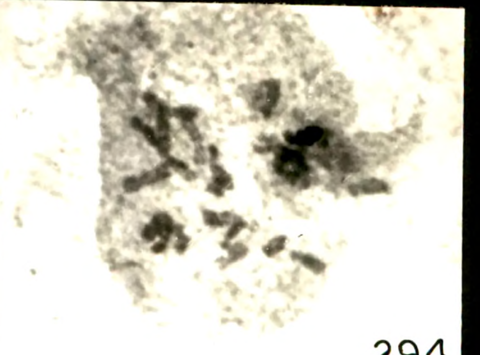
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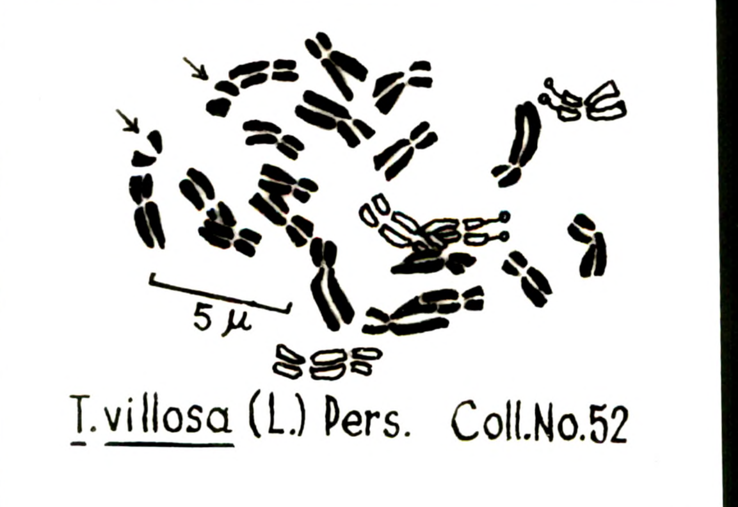

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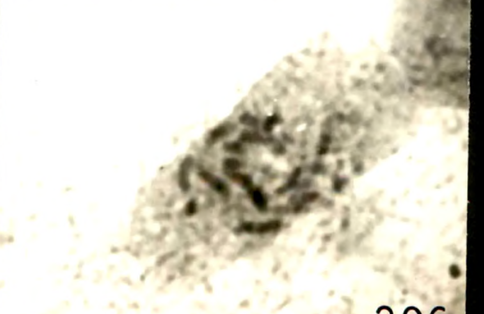

296

PL. 2 : 62

In addition the chromosome complement has 3 pairs with nearly median centromeres (G-type). Remaining 8 pairs with nearly submedian centromere are represented by F, H & J-types (1 pair of F-type, 5 pairs of H-type and 2 pairs of J-type). In addition to a secondarily constricted pair ($H^{S'}$-type) there is also one pair of chromosomes having satellites (H^{S}-type). The determined absolute length and mean length values are 27.030 μ and 1.22 μ respectively for the complement. The L/S ratio of 1.66 and TF% of 34.30% indicate the asymmetrical nature of the karyotype and idiogram (Figs. 295,296,297).

Coll. No. 9 :

Karyotype formula : $2n = 22 = F_4+G_2+H_2^{S'}+H_{10}+J_4$

(Table 2:46)

The analysis of karyotype of this population greatly resembles to coll. No. 20. But minor structural differences in distribution of various types of chromosomes is evident. Like the coll. No. 20, in the somatic complement of this population, only one pair is having nearly median centromeres. Among the 10 pairs with nearly submedian centromeres, 2 pairs belong to F-type, 2 pairs to J-type and 6 pairs to H-type. One pair of H-type is having secondary constrictions on its long arms ($H^{S'}$-type). The differences are also reflected in absolute length and mean length values, which are 26.831 μ and 1.22 μ for this collection. The TF% 32.94% and idiogram

Tephrosia villosa

Coll. No. 52 (Contd.) :

(Mitosis)

Fig. 297 - Idiogram.

Coll. No. 9

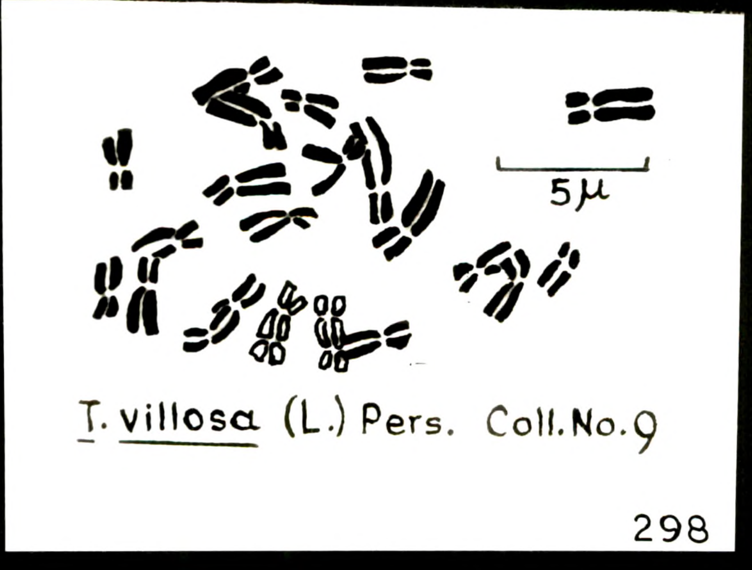
Fig. 298 - Camera lucida drawing of somatic metaphase plate.

Fig. 299 - Idiogram.

Fig. 300 - Photomicrograph of somatic metaphase plate.

Contd...

297



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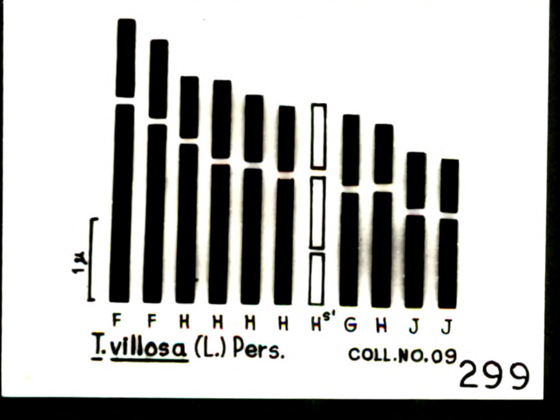

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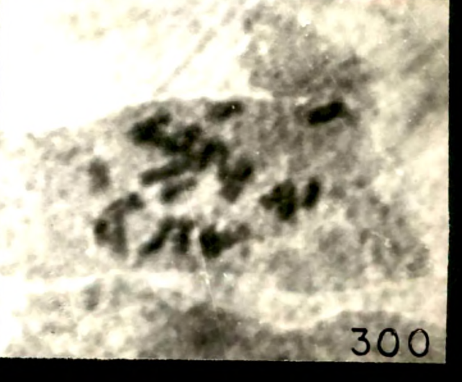

300

PL. 2 : 63

Table 2:46. Details of the karyotype analysis of <u>Tephrosia villosa</u> (L.) Pers. (Coll. No. 09).

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	2.407	+ 0.947	= 3.354	0.39	2.54	100	nsm	F
3, 4	2.170	+ 0.947	= 3.117	0.43	2.29	92	nsm	F
5, 6	1.933	+ 0.750	= 2.683	0.38	2.57	79	nsm	H
7, 8	1.697	+ 0.947	= 2.644	0.55	1.79	78	nsm	H
9,10	1.657	+ 0.829	= 2.486	0.50	1.99	74	nsm	H
11,12	1.539	+ 0.789	= 2.328	0.51	1.95	69	nsm	H
13,14	0.631 + 0.907	+ 0.750	= 2.288	0.48	2.05	68	nsm	$H^{S'}$
15,16	1.381	+ 0.868	= 2.249	0.62	1.59	67	nm	G
17,18	1.421	+ 0.710	= 2.131	0.49	2.0	63	nsm	H
19,20	1.144	+ 0.671	= 1.815	0.58	1.70	54	nsm	J
21,22	1.105	+ 0.631	= 1.736	0.57	1.75	51	nsm	J
	17.992	8.839	26.831					

L/S = 1.93

Mean length = 1.22 μ

T F % = 32.94 %

Karyotype formula = 2n = 22 = $F_4 + G_2 + H_2^{S'} + H_{10} + J_4$

indicate the asymmetrical and abruptly graded nature of the karyotype (Figs. 298, 299, 300).

In absence of striking morphological differences among the 3 collections, structural differences observed in the somatic complement of these populations should be regarded as cytotypes. Comparison of the 3 karyotypes (Table 2:47) indicate closer resemblance between coll. Nos. 20 and 9, while coll. No. 52 differs from the other two in its having a pair of satellited chromosome and 2 B-chromosomes.

In contrast to the study of Krishnappa & Basavaraj (1978) in the 3 populations analysed presently only chromosomes with nearly median and nearly submedian are observed. In addition to a pair of satellited chromosomes, one pair of chromosomes with secondary constrictions on long arms is observed, in all the 3 populations.

Meiosis is more or less regular and showed the formation of 11 distinct bivalents at diakinesis (Fig. 301, 308), metaphase I (Figs. 302, 309) and equal distribution at telophase I (Fig. 303) & anaphase I (Fig. 307). However, persistent nucleoli (Fig. 308) and groupings of bivalents (Figs. 304, 310) are observed in few pollen mother cells. Rarely a bridge formation with a fragment (Fig. 305) is noticed. In few PMCs abnormal orientation of metaphase plates, 'T' shaped (Fig. 306) is noticed. 97.47% is the determined pollen fertility for this species of _Tephrosia_.

Table 2:47. Comparison of the somatic chromosomes of different populations of *Tephrosia villosa* (L.) Pers.

Populations	Somatic number (2n)	nm Type	n s m Types				Chromosome with secondary constriction		Chromosome with satellite	Absolute length in μ	Mean length in μ	L/S
		G	C	F	H	J	$F^{S'}$	$H^{S'}$	H^{S}			
Coll.No.20	22	2	6	4	8	-	2	-	-	32.02	3.07	1.91
Coll.No.09	22	2	-	4	10	4	-	2	-	26.831	2.5	1.93
Coll.No.52	22+2B	6	-	2	6	4	-	2	2	27.03	2.64	1.66

Pl. 2: 64

Tephrosia villosa

Coll. No. 20 :

(Meiosis)

Fig. 301 - PMC showing 11 bivalents at diakinesis.

Fig. 302 - " " " " at metaphase I.

Fig. 303 - " " equal distribution at telophase I.

Fig. 304 - " " groupings of bivalents at diakinesis. $(1_{(V)}{}^{+2}{}_{(II)}{}^{+2}{}_{(I)})$

Fig. 305 - " " bridge with a fragment at telophase I.

Fig. 306 - " " 'T' shaped orientation of metaphase plates during second meiotic division.

Fig. 307 - " " early anaphase II.

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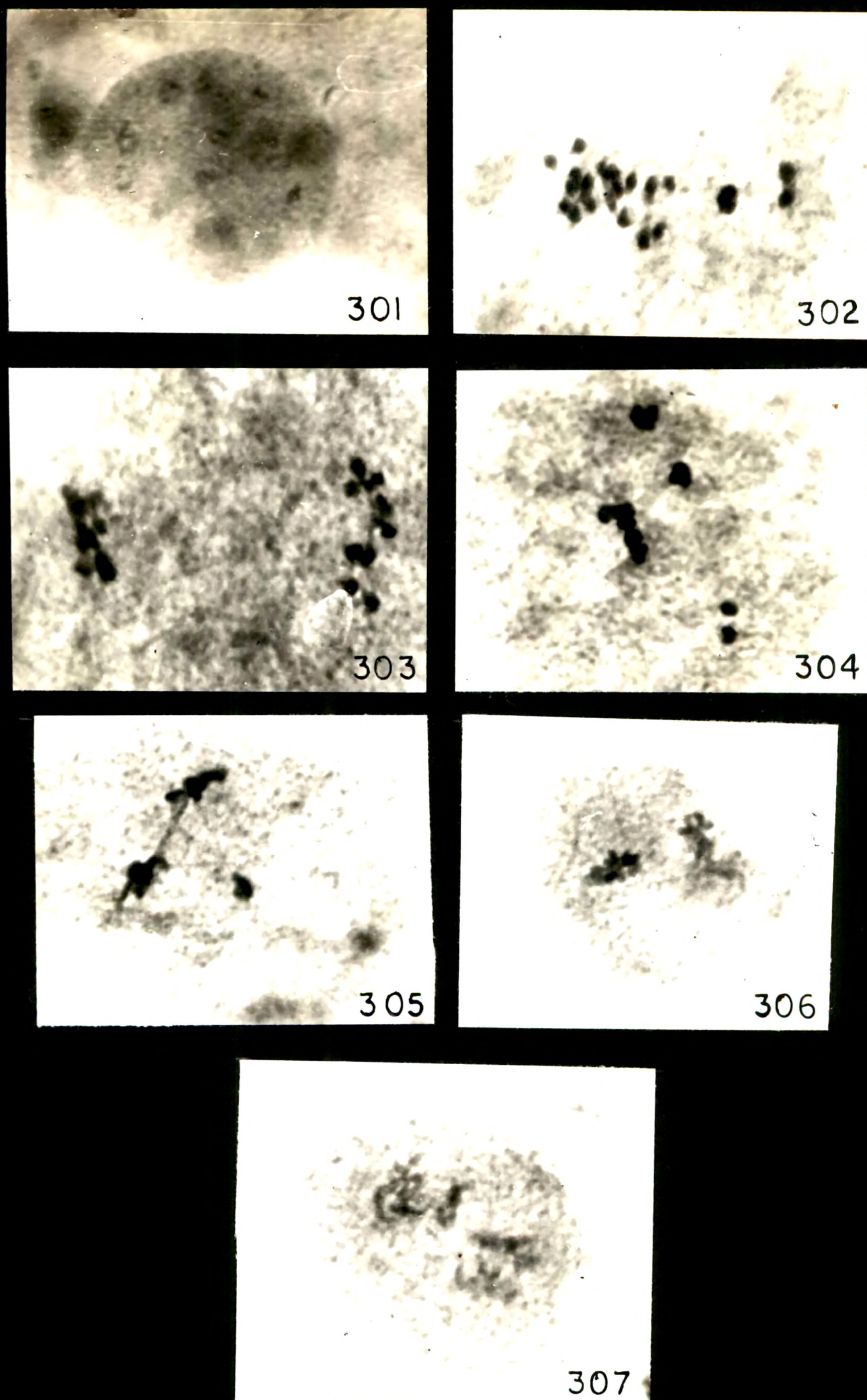

PL. 2 : 64

Pl. 2:65

Tephrosia villosa

Coll. No. 9

(Meiosis)

Fig. 308 - PMC at diakinesis showing 11 bivalents and 2 micronuclei.

Fig. 309 - " " metaphase I showing early separation of few bivalents.

Fig. 310 - " " diakinesis showing groupings of bivalents.

$(^{1}(IV)^{+2}(II)^{+3}(I))$

Tephrosia falciformis

Coll. No. 67 :

(Meiosis)

Fig. 311 - PMC showing 11 bivalents at diakinesis.

Fig. 312 - " " normal distribution at anaphase I.

Fig. 313 - " " early and late separating bivalents at metaphase I.

Fig. 314 - " " interbivalent connections at diakinesis.

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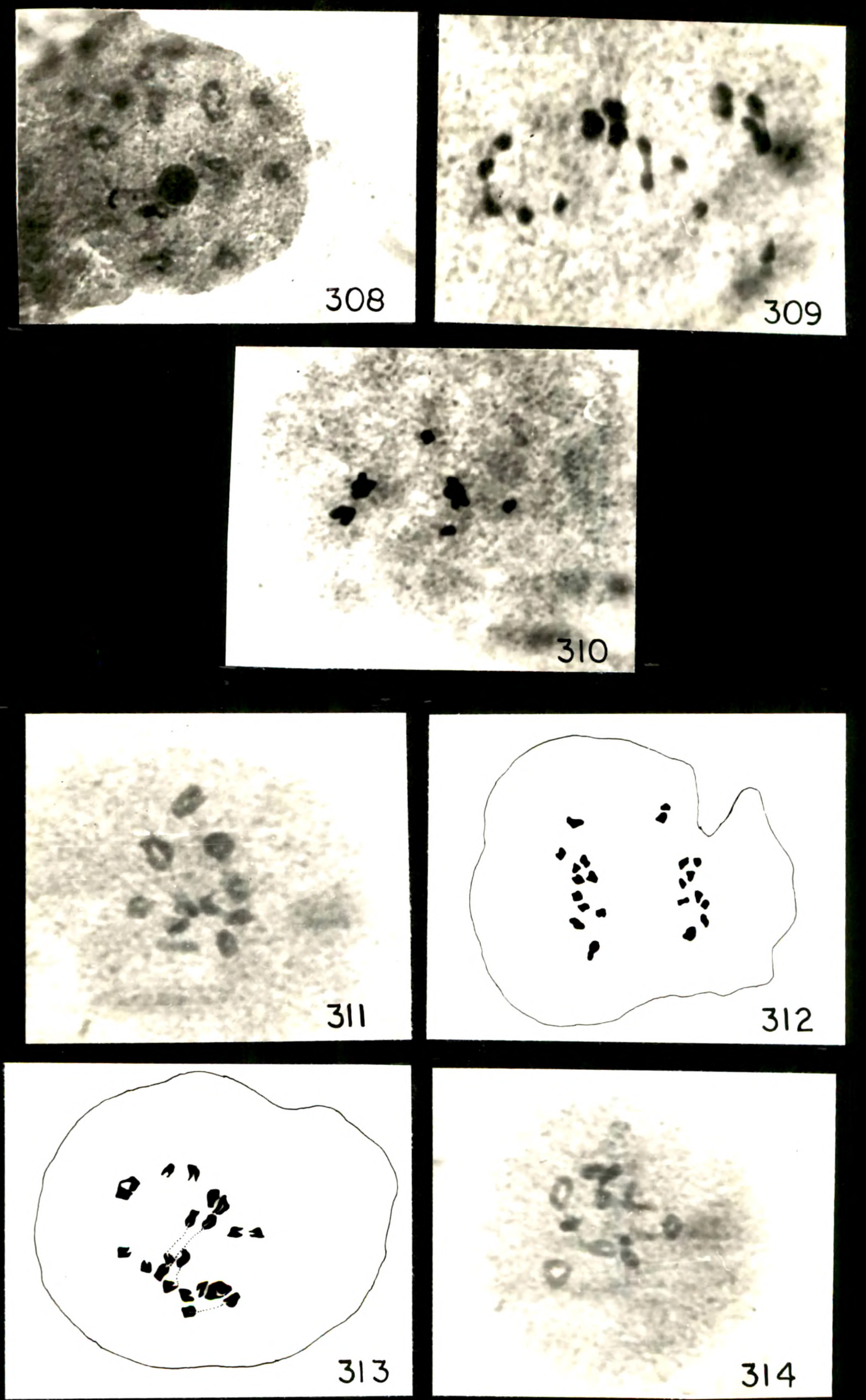


PL. 2:65

Tephrosia falciformis

Coll. No. 67 (Contd.) :

(Meiosis)

F

Fig. 315 - PMC showing non synchronised movement of one bivalent at metaphase I.

Fig. 316 - " " groupings of bivalents at late diakinesis.

Fig. 317 - " " abnormally oriented pollen tetrad.

Fig. 318 - Pollen tetrad showing micronuclei.

Tephrosia wallichii

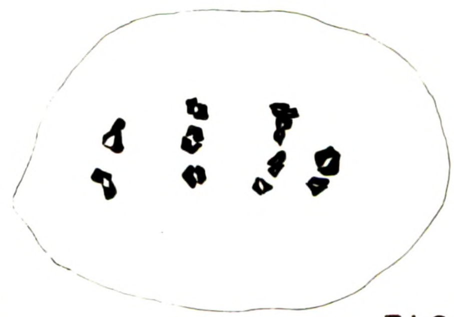
Coll. No. 53 :

(Mitosis)

Fig. 319 - Camera lucida drawing of somatic metaphase plate.

Contd....

315



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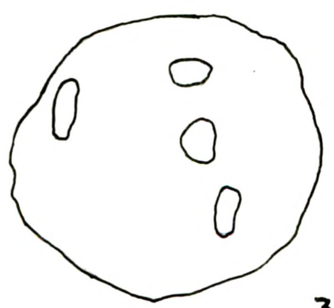

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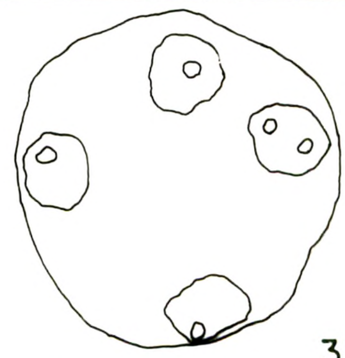

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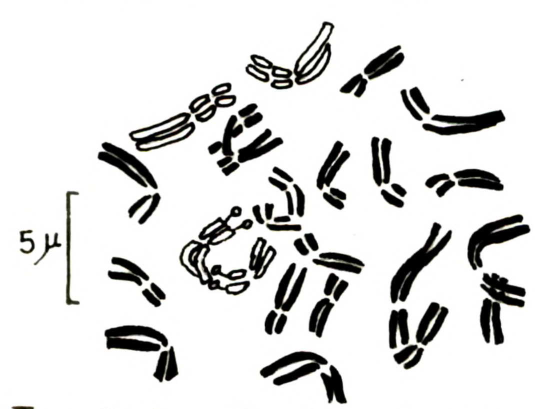


T. wallichii Grahm. Coll. No. 53

319

PL. 2 : 66

Tephrosia falciformis Ramaswamy

The taxon is very much restricted in distribution, in arid regions. Seeds procured from Jodhpur were insufficient for making mitotic preparations. Luckily seeds put in pots developed into seedlings. Out of which 2-3 plants on maturity produced flowers. From the suitable sized flower buds meiotic preparations are made. Like many other species of Tephrosia, this taxon also revealed the presence of n = 11. The haploid number reported here is the first report for the species.

Presence of 11 distinct bivalents at diakinesis (Fig. 311) and their equal distribution at anaphase I (Fig. 312) are noticed in PMCs. studied. However, in few PMCs non synchronised movement of chromosomes and presence of non congressional bivalents is noticed at metaphase I (Fig. 313, 315). In few PMCs at early and late diakinesis inter bivalent connections are evident (Figs. 311, 314) and same is reflected in various groupings of bivalents observed at later meiotic division (Fig. 316). In few cells micronuclei are seen at tetrad stage (Fig. 318). Few abnormally oriented pollen tetrads (Fig. 317) are observed at the end of second meiotic division. The pollen fertility for the species is 96.82%.

Tephrosia wallichii Grahm.

No mention of the cytological work for the taxon is seen in the available literature. Therefore, this is for the first time that species is investigated for 2n number and karyotypic analysis.

Coll. No. 53 :

Karyotype formula : $2n = 24 = A_2+B_2^{S''}+C_4+F_6+G_2^{S}+H_8$

(Table 2:48)

The karyotype of this collection is characterised in having 2 pairs with nearly median (B & G-types) and remaining 10 pairs with nearly submedian (A, C, F & H-types) centromeres. The karyotype is peculiar in showing the presence of one pair of chromosomes of A-type, which is longest in size 5.990 μ, among the *Tephrosia* species studied. Like many other species the complement also contains a pair of satellited (G^{S}-type) and a pair of secondarily constricted chromosomes ($B^{S''}$-type). Within the complement chromosome length ranges between 2.432 to 5.990 μ with a mean length of 1.79 μ. L/S ratio value of 2.46 and TF% 34.79%, indicate the abrupt asymmetry of the karyotype and the same is evident in the idiogram of this taxon (Figs. 319, 320, 321).

Coll. No. 68 :

Karyotype formula : $2n = 24 = C_2+D_2^{S''}+E_2^{S}+F_{12}+G_2+H_4$

(Table 2:49)

Table 2:48. Details of the karyotype analysis of <u>Tephrosia wallichii</u> Grahm. (Coll. No. 53).

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm +	Short Arm =	Total length	R_1	R_2			
1, 2	4.008 +	1.982 =	5.990	0.49	2.02	100	nsm	A
3, 4	3.017 +	1.621 =	4.638	0.53	1.86	77	nsm	C
5, 6	3.017 +	1.576 =	4.593	0.52	1.91	76	nsm	C
7, 8	2.702 +	0.991 ÷ 0.855 =	4.548	0.68	1.46	75	nm	$B^{S''}$
9,10	2.297 +	1.126 =	3.423	0.49	2.03	57	nsm	F
11,12	2.162 +	0.901 =	3.063	0.41	2.39	51	nsm	F
13,14	1.937 +	1.126 =	3.063	0.58	1.72	51	nsm	F
15,16	2.027 +	0.946 =	2.973	0.46	2.14	49	nsm	H
17,18	2.027 +	0.856 =	2.883	0.42	2.36	48	nsm	H
19,20	1.666 +	1.171 =	2.837	0.70	1.42	47	nm	G^S
21,22	1.666 +	0.991 =	2.657	0.59	1.68	44	nsm	H
23,24	1.576 +	0.856 =	2.432	0.54	1.84	40	nsm	H
	28.102	14.998	43.100					

L/S = 2.46

Mean length = 1.79 μ

T F % = 34.79 %

Karyotype formula = 2n = 24 = $A_2 + B_2^{S''} + C_4 + F_6 + G_2^S + H_8$

Table 2:49. Details of the karyotype analysis of <u>Tephrosia wallichii</u> Grahm. (Coll. No. 68).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	3.017	+	1.261	=	4.278	0.41	2.39	100	nsm	C
3, 4	2.252	+	0.901 0.765	=	3.918	0.73	1.35	91	nm	$D^{S''}$
5, 6	2.702	+	1.081	=	3.783	0.40	2.49	88	nsm	F
7, 8	2.297	+	1.306	=	3.603	0.56	1.75	84	nsm	F
9,10	2.657	+	0.901	=	3.558	0.33	2.94	83	SM	E^S
11,12	2.251	+	1.081	=	3.332	0.48	2.08	77	nsm	F
13,14	2.161	+	1.036	=	3.197	0.47	2.08	74	nsm	F
15,16	1.981	+	1.171	=	3.152	0.54	1.69	73	nsm	F
17,18	2.071	+	0.991	=	3.062	0.47	2.08	71	nsm	F
19,20	1.666	+	0.946	=	2.612	0.56	1.76	61	nsm	H
21,22	1.756	+	0.766	=	2.522	0.43	2.29	58	nsm	H
23,24	1.396	+	1.036	=	2.432	0.74	1.34	56	nm	G
	26.207		13.242		39.449					

L/S = 1.75

Mean length = 1.64 μ

T F % = 33.56 %

Karyotype formula = 2n = 24 = $C_2 + D_2^{S''} + E_2^S + F_{12} + G_2 + H_4$

Pl. 2:67

Tephrosia wallichii

Coll. No. 53 (contd.) :

(Mitosis)

Fig. 320 - Idiogram.

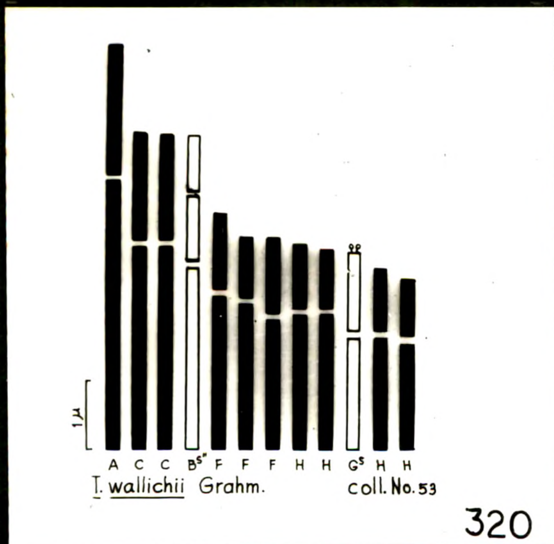
Fig. 321 - Photomicrograph of somatic metaphase plate.

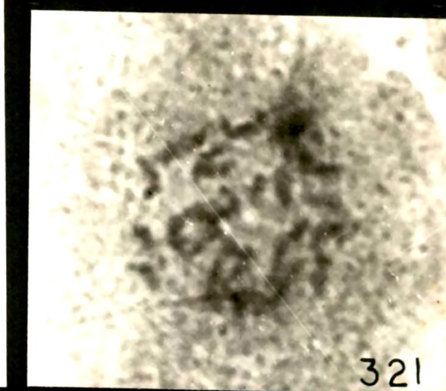
Coll. No. 68 :

Fig. 322 - Camera lucida drawing of somatic metaphase plate.

Fig. 323 - Idiogram.

Fig. 324 - Photomicrograph of somatic metaphase plate.


1μ
A C C B^S" F F F H H G^S H H
T. wallichii Grahm.
coll. No. 53
320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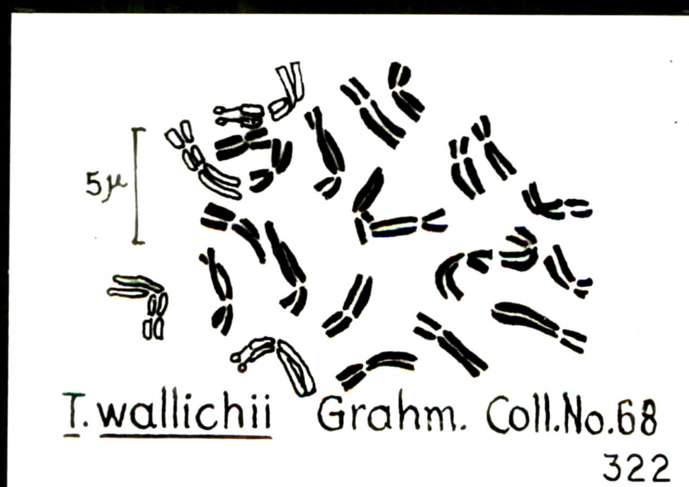
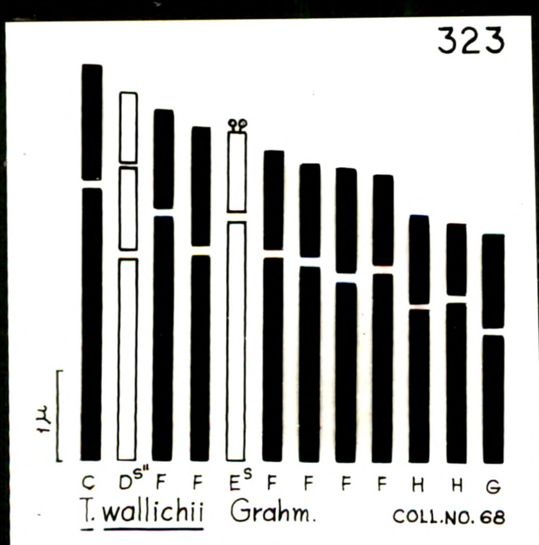
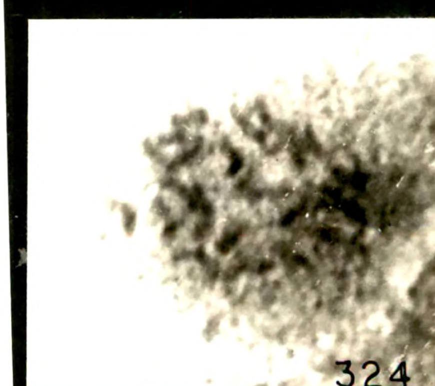

5μ
T. wallichii Grahm. Coll. No. 68
322


323
1μ
C D^S" F F E^S F F F F H H G
T. wallichii Grahm.
COLL. NO. 68


324

PL. 2 : 67

The karyotype of this population has 2 pairs with nearly median (D & G-types), one pair with submedian (E-type) and 9 pairs with nearly submedian (C, F & H-types). Like the preceding collection, a pair of chromosomes with secondary constrictions on short arms and a pair with satellites are observed. A glance at relative length values of chromosome pairs reveal more or less smooth gradation, except at the end, and less asymmetrical nature of the karyotype and idiogram. The lesser values of L/S ratio (1.75) and TF% (33.56) also point towards the same (Figs. 322, 323, 324).

It is evident from the above mentioned account that the two populations represented by coll. Nos. 53 and 68 differ from each other in minute structural details. Such as; types of chromosomes, number of pairs having nearly median, submedian and nearly submedian centromeres. Moreover, conspicuous differences in the absolute length, mean length and L/S ratio are evident (Table 2:50). The populations therefore, probably represent two cytotypes of the species. However, doubt is created because the seeds of both populations collected from different localities showed slight differences in size and colour. Populations raised from these seeds did not flower, with the result that the correct identity of the two collections could not be ascertained. However, the vegetative plant did show resemblance in morphological features. Even then, the two populations may be two infra-specific taxa belonging to distinct but closely related species.

Table 2:50. Comparison of somatic chromosomes of different populations of *Tephrosia wallichii* Grahm.

Populations	Somatic number (2n)	n m Types D	n m Types B	n m Types G	S M Type E	n s m Types A	n s m Types C	n s m Types F	n s m Types H	Chromosome with secondary constriction Types B^S	Chromosome with secondary constriction Types D^S	Chromosome with satellite Types G^S	Chromosome with satellite Types E^S	Absolute length in μ	Mean length in μ	L/S
Coll.No.53	24	-	2	2	-	2	4	6	8	2	-	2	-	43.100	1.79	2.46
Coll.No.68	24	2	-	2	2	-	2	12	4	-	2	-	2	39.449	1.64	1.75

Tephrosia candida DC.

2n = 22 have been reported for the species by Kedhar Nath (1950), Frahm-Leliveld (1957). Present cytological study of the taxon is in confirmation with the earlier reports. This is further supplemented by meiotic division which reveals n=11.

Coll. No. 62 :

Karyotype formula : $2n = 22 = F_2^{S''} + F_2 + H_2^{S'} + H_{10} + J_6$

(Table 2:51)

The somatic complement contains 8 pairs of medium (2.026 to 3.287 μ), 3 pairs of short (1.531 to 1.891 μ) sized chromosomes. The medium sized chromosomes are represented by F & H-types, while short sized ones are represented by J-type only. One pair of F-type chromosome is having secondary constrictions on its short arms ($F^{S''}$-type). Another pair having secondary constrictions on long arms is represented by $H^{S'}$-type. The noteworthy features of the chromosome structure of the complement is that all the chromosomes are with nearly submedian centromeres. Satellited chromosomes are not noticed in the somatic complement of the species.

Chromosomes with nearly median or submedian centromeres as observed in other species of Tephrosia are completely absent in this. The determined values of L/S ratio, TF% and mean length are 2.14, 33.10% and 1.19 μ respectively. These values point towards the asymmetrical nature of the karyotype. Idiogram is of the graded nature (Figs. 325, 326).

Pl. 2:68

Tephrosia candida

Coll. No. 62 :

(Mitosis)

Fig. 325- Camera lucida drawing of somatic metaphase plate.

Fig. 326 - Idiogram.

(Meiosis)

Fig. 327 - PMC showing non congressional bivalents at metaphase I (Polar view).

Fig. 328 - " " non congressional bivalent at metaphase I (side view).

Fig. 329 - " " interbivalent connections between bivalents at late diakinesis.

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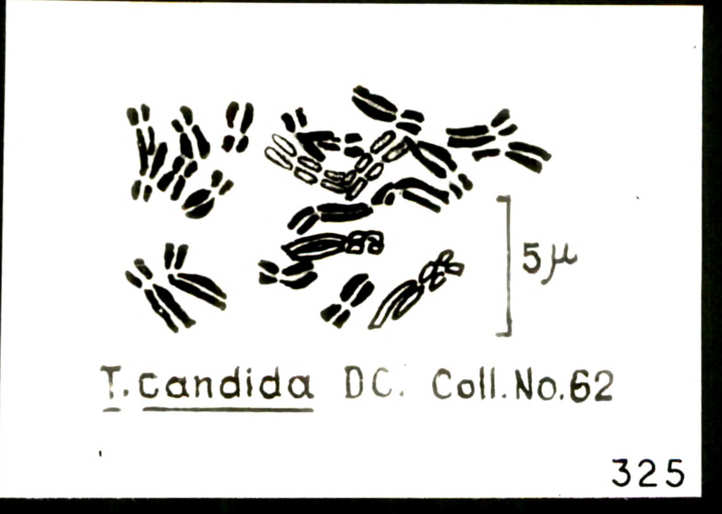

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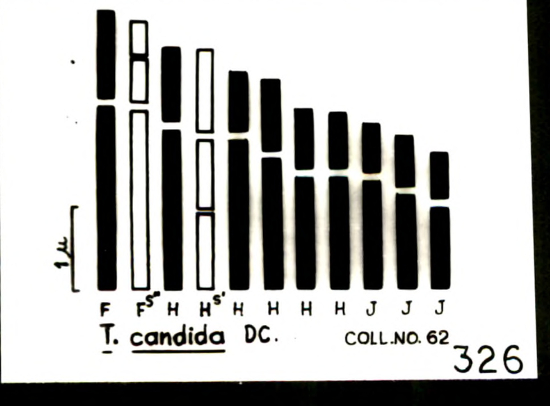

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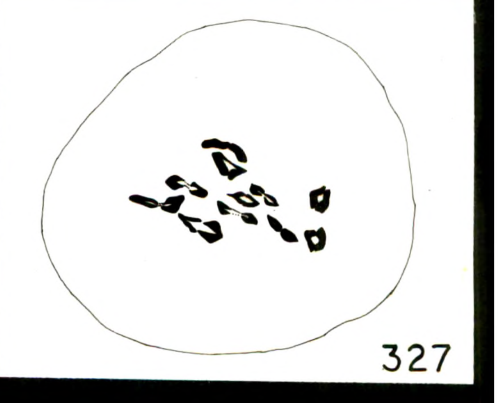

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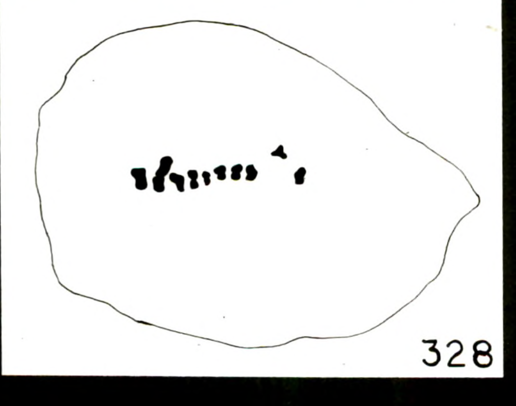

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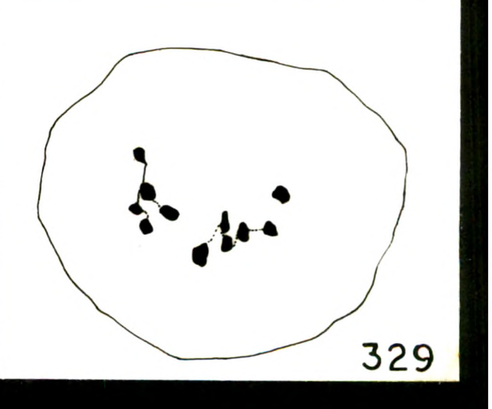

329

PL. 2:68

Table 2:51. Details of the karyotype analysis of <u>Tephrosia candida</u> DC. (Coll. No. 62).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.206	+	1.081	=	3.287	0.49	2.04	100	nsm	F
3, 4	2.162	+	0.540 + 0.405	=	3.107	0.43	2.28	94	nsm	$F^{S''}$
5, 6	1.936	+	0.901	=	2.837	0.46	2.14	86	nsm	H
7, 8	0.946 + 0.810	+	1.036	=	2.792	0.58	1.69	84	nsm	$H^{S'}$
9,10	1.801	+	0.721	=	2.522	0.40	2.49	76	nsm	H
11,12	1.576	+	0.856	=	2.432	0.54	1.84	73	nsm	H
13,14	1.351	+	0.721	=	2.072	0.53	1.87	63	nsm	H
15,16	1.351	+	0.675	=	2.026	0.49	2.00	61	nsm	H
17,18	1.306	+	0.585	=	1.891	0.44	2.23	57	nsm	J
19,20	1.126	+	0.631	=	1.757	0.56	1.78	53	nsm	J
21,22	0.991	+	0.540	=	1.531	0.54	1.83	46	nsm	J
	17.562		8.692		26.254					

L/S = 2.14
Mean length = 1.19 μ
μ T F % = 33.10 μ
Karyotype formula = 2n = 22 = $F_2^{S''} + F_2 + H_2^{S'} + H_{10} + J_6$

Meiotic study of the taxon showed the presence of 11 distinct bivalents at diakinesis. Nucleolus is often seen to persist even at late diakinesis (Fig. 327). At metaphase I, the 11 bivalents are disposed off in slight irregular manner. Among them a few non congressional ones, which show the configuration of late diakinesis (Figs. 327, 328). Few PMCs show interbivalent connections (Fig. 329). Except for these abnormalities, the meiosis is regular. Normal distribution is observed at anaphase I.

The species is a cultivated one which is grown in gardens for its white flowers.

<u>Tephrosia purpurea</u> (L.) Pers.

Both n and 2n numbers have been reported for the species by various workers. Based on meiotic studies n = 11 and 12 have been reported by Tandon & Malik (1961) while, Bir & Sidhu (1967) have reported n = 11. The somatic numbers have been reported as 2n = 24 by Ramanathan (1950), Bhatt (1976). In contrast to this 2n = 22 for the taxon is reported by workers such as Miege (1960), Venkateswarlu & Kameswara Rao (1963), Singh, Raina & Joshi (1976), Krishnappa & Basavaraj (1978) and Shastri (1979). The present study of 2 populations collected from Gujarat State, showed n = 12 and 2n = 24.

<u>Coll. Nos. 56 and 61</u> :

Karyotype formulae : $2n=24 + 2B = D_2^{S''}+D_2+F_4+G_6+H_2^{S}+H_4$

(Table 2:52)

Table 2:52. Details of the karyotype analysis of <u>Tephrosia purpurea</u> (L.) Pers. (Coll. No. 56).

Chromosome pair	Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	Arm Ratios R_2	Relative length	Centromere	Type
1, 2	2.012	+	1.776	=	3.788	0.88	1.13	100	nm	D
3, 4	2.171	+	0.789+ 0.710	=	3.670	0.69	1.44	96	nm	$D^{S''}$
5, 6	2.328	+	1.144	=	3.472	0.49	2.03	91	nsm	F
7, 8	1.973	+	1.065	=	3.038	0.53	1.85	80	nsm	F
9,10	1.973	+	0.986	=	2.959	0.50	2.0	78	nsm	H^S
11,12	1.736	+	1.184	=	2.920	0.68	1.46	77	nm	G
13, 14	1.855	+	0.828	=	2.683	0.44	2.24	70	nsm	H
15,16	1.618	+	0.986	=	2.604	0.61	1.63	68	nm	G
17,18	1.697	+	0.789	=	2.486	0.46	2.15	65	nsm	H
19,20	1.657	+	0.710	=	2.367	0.42	2.33	62	nsm	H
21,22	1.460	+	0.710	=	2.170	0.48	2.05	57	nsm	H
23,24	1.302	+	0.268	=	2.170	0.66	1.5	57	nm	G
	21.782		12.545		34.327					

L/S = 1.75

Mean length = 1.43 μ

T F % = 36.54 %

Karyotype formula = $2n = 24 + 2B = D_2^{S''} + D_2 + F_4 + G_6 + H_2^S + H_8$

The somatic complement of the species has all the chromosomes which are of medium sized ranging in length from 2.170 to 3.788 μ with a mean length of 1.43 μ. Chromosomes with nearly median centromeres are represented by 5 pairs distributed in D & G-types, while the remaining 7 pairs having nearly submedian centromeres are distributed in F & H-types. Among these one pair of D-type is with secondary constrictions on short arms and other pair of H-type is satellited. In addition, the populations studied revealed the presence of 2B-chromosomes in their somatic complement. The L/S ratio of 1.75 is comparatively lower than many other species of Tephrosia presently studied. The TF% is 36.54% which also depicts less asymmetrical nature of the karyotype and idiogram (Figs. 331, 332 & 333).

The present karyotypic analysis differs from that of Bhatt (1974), in total absence of chromosomes with median centromeres. However, the two analysis share the common feature of having one pair of secondarily constricted and one pair of satellited chromosomes. The populations analysed by Krishnappa & Basavaraj (1978) revealed the presence of 7 pairs with nearly median and 4 pairs with nearly submedian centromeres. While the present analysis reveals the presence of 5 pairs of chromosomes with nearly median and 7 pairs with nearly submedian centromeres. Shastri (1979) in his study of the taxon having 2n = 22, reported the presence of 10 pairs having median centromeres and only one pair with submedian

Pl. 2:69

Tephrosia candida

Coll. No. 62 (Contd.) :

(Meiosis)

Fig. 330 - Camera lucida drawing of PMC showing normal distribution of chromosomes at anaphase I.

Tephrosia purpurea

Coll. No. 56 :

Fig. 331 - Camera lucida drawing of somatic metaphase plate.

Fig. 332 - Idiogram.

Fig. 333 - Photomicrograph of somatic metaphase plate.

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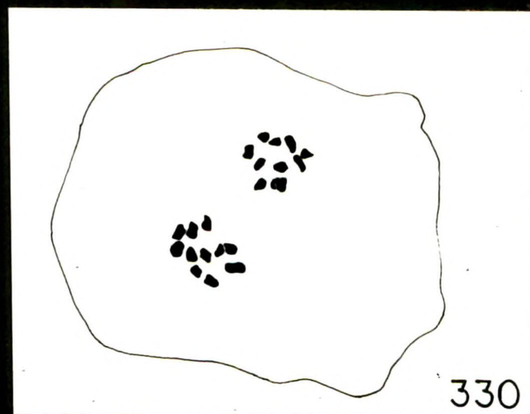
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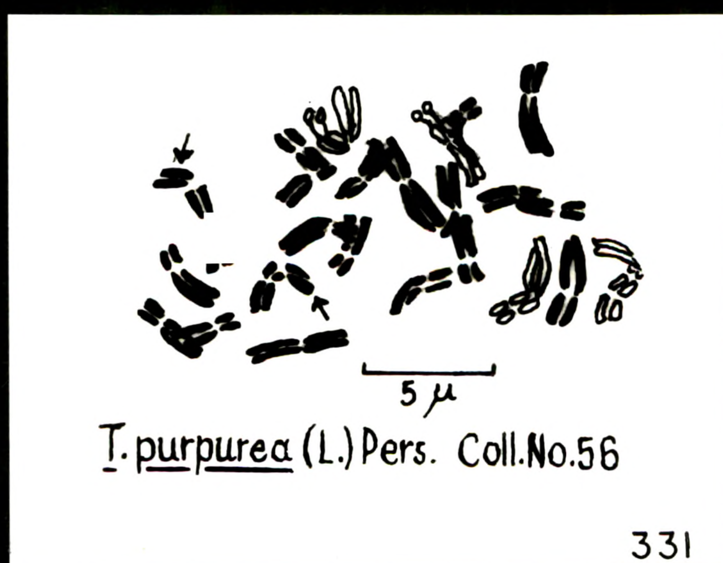
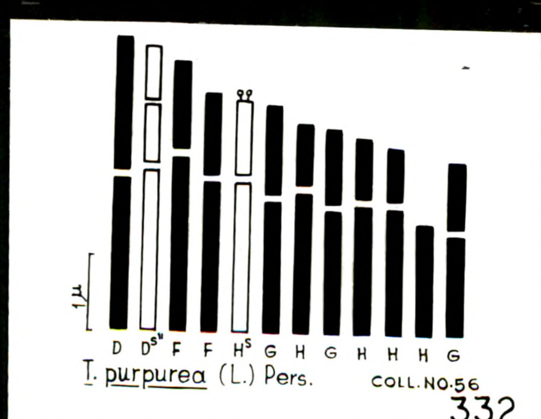
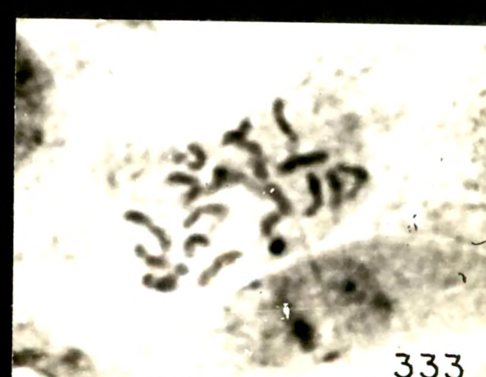

5 μ
T. purpurea (L.) Pers. Coll.No.56
331


1 μ
D $D^{S''}$ F F H^{S} G H G H H H G
T. purpurea (L.) Pers.
COLL.NO.56
332


333

PL. 2:69

Pl. 2:70

Tephrosia purpurea

Coll. No. 56 :

(Meiosis)

Fig. 334 -	PMC showing early diakinesis.		
Fig. 335 -	"	"	12 bivalents along with 2-B-chromosomes at metaphase I (side view).
Fig. 336 -	"	"	bridge formation at anaphase I.
Fig. 337 -	"	"	non congressional bivalent at anaphase I.
Fig. 338 -	"	"	non congressional B-chromosomes at telophase I.
Fig. 339 -	"	"	telophase II.
Figs. 340 and 341 -	PMCs	"	cytomixis.

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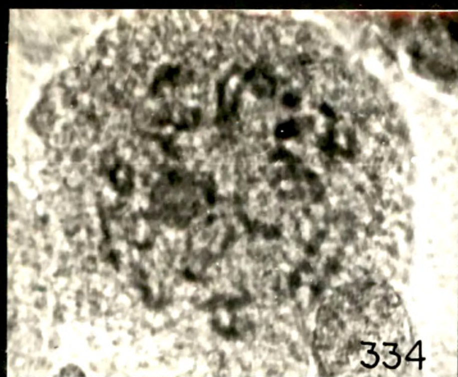

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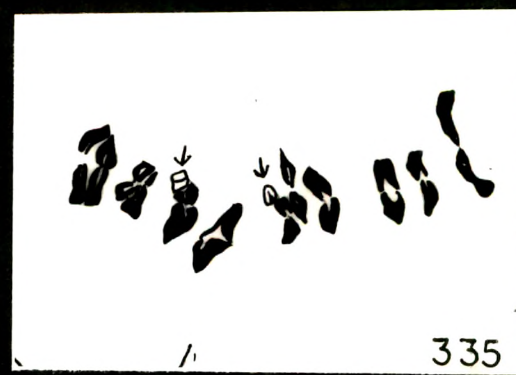

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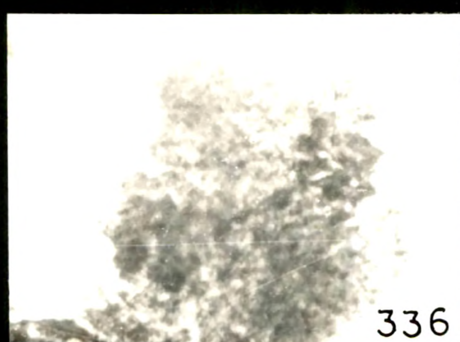

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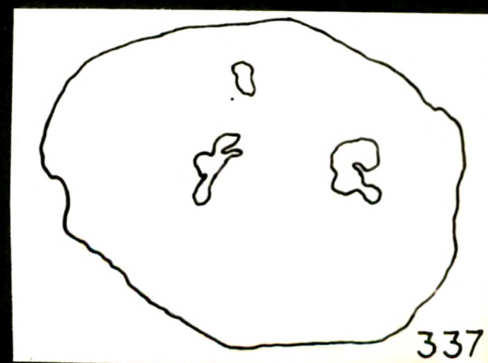

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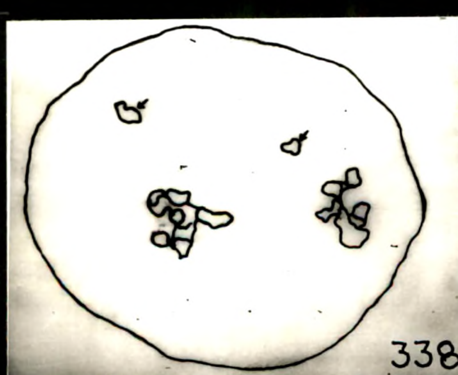

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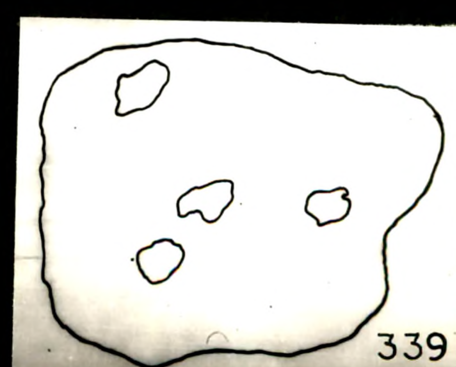

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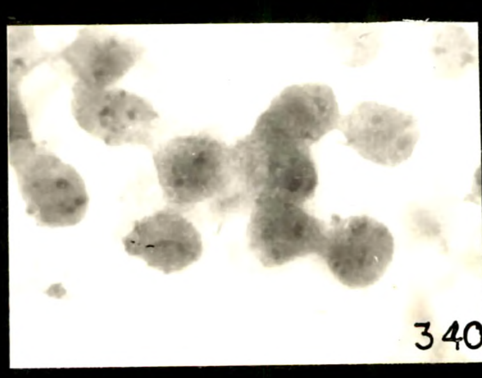

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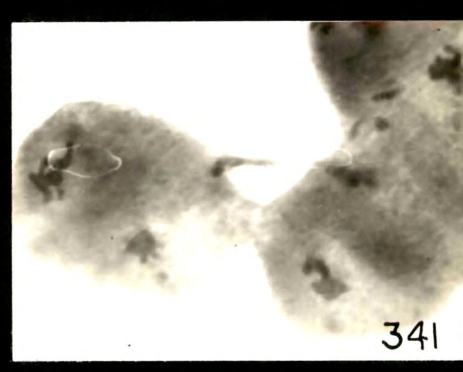

341

PL. 2 : 70

Pl. 2:71

Tephrosia purpurea

Coll. No. 5 :

(Meiosis)

Fig. 342 - PMC showing nucleolus, B-chromosomes and 12 distinct bivalents at diakinesis.

Fig. 343 - " " interbivalent connections and B-chromosomes at late diakinesis.

Fig. 344 - " " 12 bivalents and 2 B-chromosomes at metaphase I (side view).

Fig. 345 - " " non congressional chromosomes at telophase I (probably B-chromosomes).

Tephrosia pumila

Coll. No. 1:

(Mitosis)

Fig. 346 - Camera lucida drawing of somatic metaphase plate.

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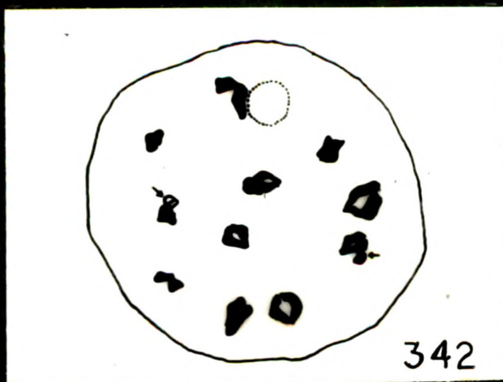
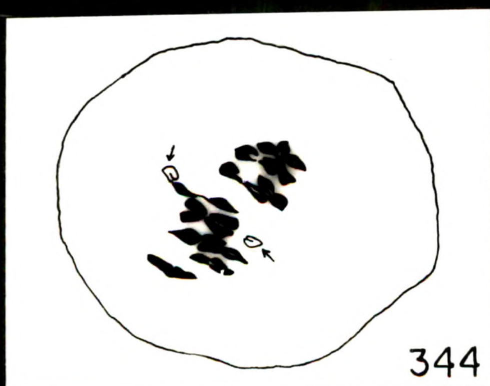


342

343



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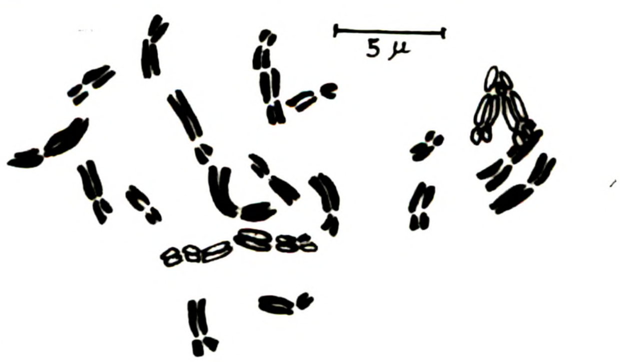

T. pumila (Lamk.) Pers. Coll. No. 1

346

PL. 2 : 71

centromeres. Probably due to over condensation of chromosomes failed to reveal the correct morphology. None of the earlier workers made any reference to the presence of a chromosome pair having secondary constrictions. While both the populations analysed presently clearly showed the presence of such a pair in their chromosome complements.

The somatic number 2n = 24, is confirmed by the presence of 12 distinct bivalents at diakinesis and metaphase (Figs. 334, 335 & 344). Abnormalities such as persistent nucleolus and nucleoli (Fig. 342), stickiness of bivalents resulting in formation of bridge at telophase I (Fig. 336) are noticed in few PMCs. During secondary meiotic division, normal tetrads are frequently observed (Fig. 339) but occasionally secondary groupings of chromosomes and non congressional chromosomes (probably B-chromosomes) (Figs. 337, 338, 345) and cytomixis (Figs. 340 & 341) are noticed. Distribution of B-chromosomes during meiosis is very irregular and many a times they can be identified as darkly stained bodies lying isolated from the chromosome complement (Figs. 335, 337, 338). Interbivalent connection along with B-chromosomes are observed (Fig. 343) at late diakinesis. The pollen fertility 95.15%, is determined for the species.

Tephrosia pumila (Lamk.) Pers.

The species has been earlier investigated by Ramanathan

(1955), Krishnappa & Basavaraj (1978), Sanjappa (1978). 2n = 22 is reported by Krishnappa & Basavaraj (1978), Sanjappa (1978) while 2n = 24 has been reported by Ramanathan (1955). 2n = 22 and n = 11 are encountered in present study.

Coll. No. 1 :

Karyotype formula : $2n = 22 = B_2+D_2^{S''}+D_2+F_2+G_2+H_2^{S'}+H_6+J_4$

(Table 2:53)

The somatic metaphase complements broadly fall into three groups based on length viz., long sized, medium sized and short sized. The complement contains one pair in the first group (B-type) which are with nearly median centromeres. Medium sized chromosomes are represented by D, F, G & H-types. Out of 2 pairs of D-type chromosomes, one pair is with secondary constrictions on short arms ($D^{S''}$-type). Similarly out of 4 pairs of medium sized chromosomes with nearly sub-median centromeres (H-type). Only one pair has secondary constrictions on long arms ($H^{S'}$-type). 2 pairs of short sized chromosomes with nearly submedian centromeres are represented by J-type. The total length of chromosomes is 30.399 μ. Mean length of the chromosomes in complement is 1.38 μ. The determined values of TF% and L/S ratio are 37.18% and 2.59 respectively. These values and idiogram point towards the asymmetry and graded nature of the karyotype (Figs. 346, 347, 348).

Pl. 2:72

Tephrosia pumila

Coll. No. 1 (Contd.) :

(Mitosis)

Fig. 347 - Idiogram.

Fig. 348 - Photomicrograph of somatic metaphase plate.

Coll. No. 57 :

Fig. 349 - Camera lucida drawing of somatic metaphase plate.

Fig. 350 - Idiogram.

Fig. 351 - Photomicrograph of somatic metaphase.

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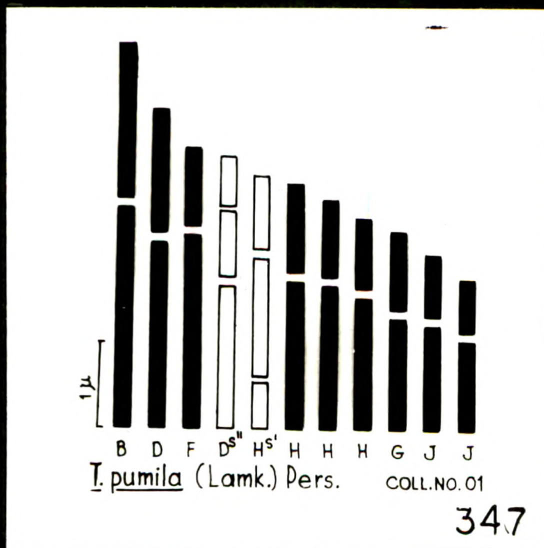

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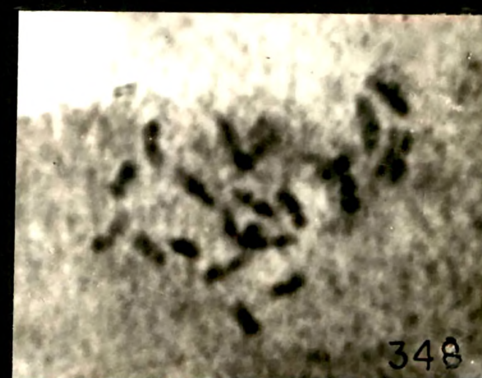
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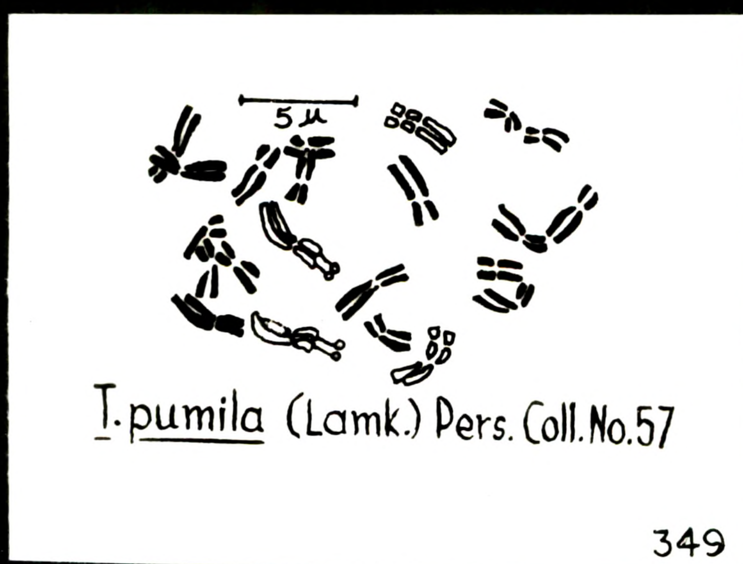

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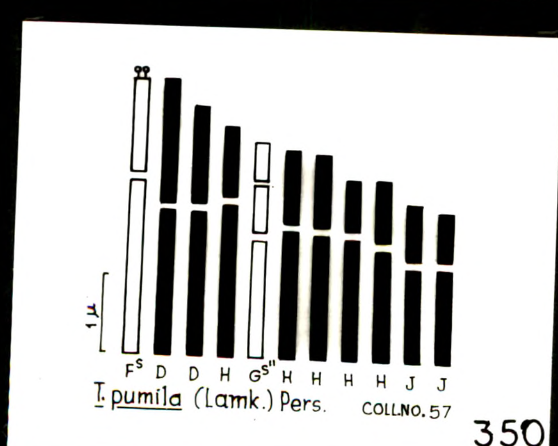

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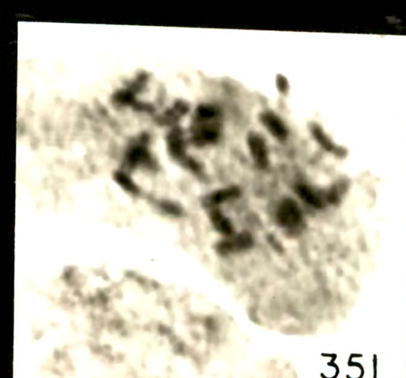
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PL. 2 : 72

Table 2:53. Details of the karyotype analysis of <u>Tephrosia pumila</u> (Lamk.) Pers. (Coll. No. 01).

Chromosome pair	Length in μ			Arm Ratios		Relative length	Centromere	Type
	Long Arm +	Short Arm =	Total length	R_1	R_2			
1, 2	2.567 +	1.756 =	4.323	0.68	1.46	100	nm	B
3, 4	2.162 +	1.441 =	3.603	0.66	1.50	83	nm	D
5, 6	2.297 +	0.901 =	3.198	0.39	2.54	73	nsm	F
7, 8	1.666 +	0.766+ 0.585 =	3.017	0.81	1.23	69	nm	$D^{S''}$
9,10	0.540+ 1.396 +	0.856 =	2.792	0.44	2.26	64	nsm	$H^{S'}$
11,12	1.711 +	1.036 =	2.747	0.60	1.65	63	nsm	H
13,14	1.666 +	0.901 =	2.567	0.54	1.84	59	nsm	H
15,16	1.531 +	0.811 =	2.342	0.52	1.88	54	nsm	H
17,18	1.306 +	0.901 =	2.207	0.68	1.44	51	nm	G
19,20	1.216 +	0.721 =	1.937	0.59	1.68	44	nsm	J
21,22	1.036 +	0.630 =	1.666	0.60	1.64	38	nsm	J
	19.094	11.305	30.399					

L/S = 2.59

Mean length = 1.38 μ

T F % = 37.18%

Karyotype formula = $2n = 22 = B_2 + D^{S''}_2 + D_2 + F_2 + G_2 + H^{S'}_2 + H_6 + J_4$

Coll. No. 57 :

Karyotype formula : $2n = 22 = D_4+F^S_2+G^{S''}_2+H_{10}+J_4$

(Table 2:54)

The somatic complement contains medium to short sized chromosomes. 8 pairs of chromosomes (F, H & J-types) have nearly submedian and 3 pairs (D & G-types) have nearly median centromeres. The complement contains one pair of satellited and one pair of secondarily constricted chromosomes represented by F^S and $G^{S''}$ types, respectively. The later has secondary constrictions on short arms. The chromosome length ranges between 1.847 to 3.513 μ with a mean length of 1.32 μ. L/S ratio and TF%, 1.90 and 37.19%, calculated for the taxon, abruptly graded and asymmetrical nature of the idiogram & karyotype (Figs. 349, 350, 351).

The population (Coll. No. 57) differs from the previous one (Coll. No. 1) in minor structural details regarding the number of pairs having nearly median and nearly submedian centromeres. Moreover, long sized chromosomes (B-type) observed in coll. No. 1 and secondarily constricted chromosome with secondary constrictions on long arms, represented by a pair each are not encountered in coll. No. 57. However, both the populations share a common feature of having one pair of chromosomes having secondary constrictions on long arms. Somatic complement of coll. No. 57 also differs from the other one, in having satellites on the longest pair of the

Table 2:54. Details of the karyotype analysis of <u>Tephrosia pumila</u> (Lamk.) Pers. (Coll. No. 57).

Chromosome pair	Length in μ					Arm Ratios		Relative length	Centromere	Type
	Long Arm	+	Short Arm	=	Total length	R_1	R_2			
1, 2	2.297	+	1.216	=	3.513	0.52	1.88	100	nsm	F^S
3, 4	1.892	+	1.621	=	3.513	0.85	1.16	100	nm	D
5, 6	1.892	+	1.261	=	3.153	0.66	1.50	89	nm	D
7, 8	1.981	+	0.901	=	2.882	0.45	2.19	82	nsm	H
9,10	1.531	+	0.631+ 0.495	=	2.657	0.73	1.35	75	nm	$G^{S''}$
11,12	1.666	+	0.946	=	2.612	0.56	1.76	74	nsm	H
13,14	1.621	+	0.946	=	2.567	0.58	1.71	73	nsm	H
15,16	1.576	+	0.676	=	2.252	0.42	2.33	64	nsm	H
17,18	1.441	+	0.811	=	2.252	0.56	1.77	64	nsm	H
19,20	1.216	+	0.721	=	1.937	0.59	1.68	55	nsm	J
21,22	1.216	+	0.631	=	1.847	0.51	1.92	52	nsm	J
	18.329		10.856		29.185					

L/S = 1.90

Mean length = 1.32 μ

T F % = 37.19 %

Karyotype formula = 2n = 22 = $D_4 + F_2^S + G_2^{S''} + H_{10} + J_4$

Table 2:55. Comparison of the somatic chromosomes of different populations of *Tephrosia pumila* (Lamk.) Pers.

Populations	Somatic number (2n)	nm Types B	nm Types D	nm Types G	nsm Types F	nsm Types H	nsm Types J	Sec.cons. on long arms $H^{S'}$	Sec.cons. on short arms $D^{S''}$	Sec.cons. on short arms $G^{S''}$	Satellited chromosome F^{S}	Absolute length in u	Mean length in u	L/S
Coll.No. 01	22	2	4	2	2	8	4	2	2	-	-	30.399	1.38	2.59
Coll.No. 57	22	-	4	2	2	10	4	-	-	2	2	29.185	1.32	1.90

<u>Pl. 2:73</u>

<u>*Tephrosia pumila*</u>

<u>Coll. No. 1</u> :

(Meiosis)

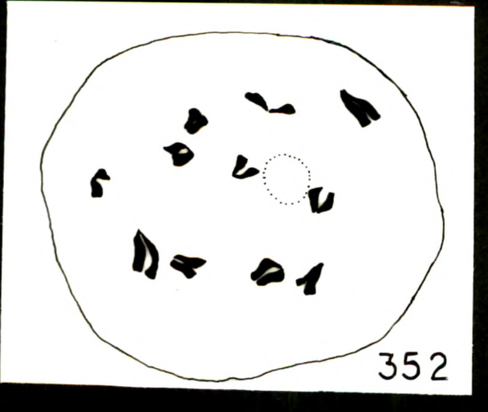
Fig. 352 - PMC showing 11 distinct bivalents and nucleolus at diakinesis.

Fig. 353 - " " 11 bivalents at late diakinesis.

Fig. 354 - " " non congressional bivalents at metaphase I.

Fig. 355 - " " secondary groupings of bivalents at diakinesis.

Fig. 356 - " " 2 laggards at telophase I.



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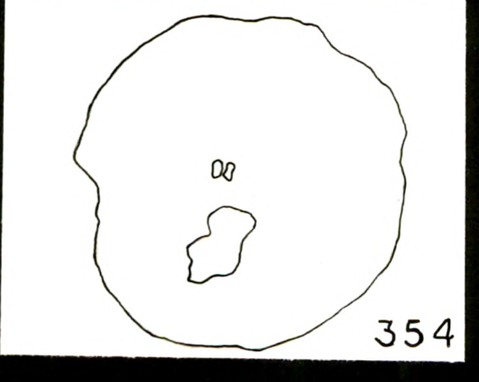

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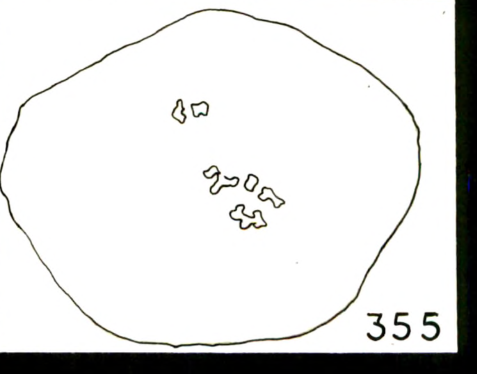

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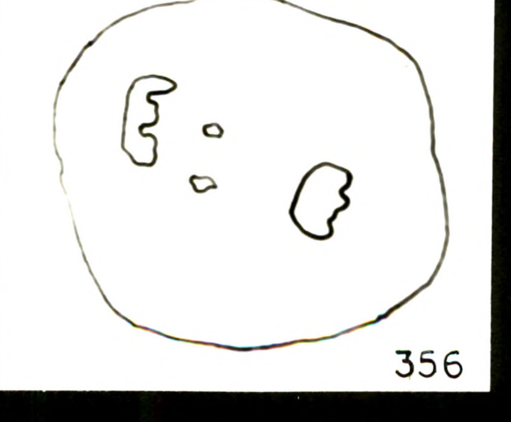

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PL. 2 : 73

complement. Other comparative values of L/S ratio, mean length etc. are presented in table 2.55.

Krishnappa & Basavaraj (1978) in their analysis report the presence of 8 pairs of chromosomes with nearly submedian and 3 pairs with subterminal centromeres. In contrast to this, the present analysis of 2 populations reveal the presence of chromosomes with nearly median or nearly submedian centromeres, Moreover, in both the populations one pair of secondarily constricted chromosome is observed.

Somatic chromosome count, 2n = 22, is confirmed by the presence of 11 bivalents at diakinesis (Figs. 352 & 353). Nucleolus is observed till late diakinesis in many PMCs. Except for secondary grouping of bivalents at diakinesis (Fig. 355), non congressional bivalents at metaphase I (Fig. 354) and laggards telophase (Fig. 356), meiosis is regular. The pollen fertility (91.03%) is quite high.

Tephrosia hamiltonii Drumm.

Review of literature revealed that the species *Tephrosia purpurea* Pers. has been tackled cytologically by number of cytologists. But this taxon viz., *T. hamiltonii* Drumm., formerly known as *T. purpurea* Baker, has not been worked out, probably because of its restricted distribution. As pointed out in the taxonomy, the two taxa deserve distinct specific status. The only chromosome number report n = 11, is by

Sanjappa & Bhatt (1976). However, in the present study 2n = 24 and n = 12 are encountered.

Coll. No. 58 :

Karyotype formula : $2n = 24 = C_2 + F_2^{S''} + F_2 + G_2 + H_{10} + I_2 + J_4$ (Table 2:56).

Like T. purpurea Pers. this species also has 24 chromosomes in the somatic complement. Long, medium and short sized chromosomes, distributed in different types are present. But for, 2 pairs of G & I-types, all the rest are having nearly submedian centromeres. The chromosome length ranges between 1.666 to 4.188 μ with a mean length of 1.33 μ. Only one pair of chromosome ($F^{S''}$-type) is with secondary constrictions on short arms (Figs. 357, 358).

Comparison of the karyotypes, taxa representing T. purpurea (L.) Pers. and T. hamiltonii Drumm. shows some striking differences in structural peculiarities of chromosomes. T. purpurea has 5 pairs with nearly median centromeres while T. hamiltonii has only 2 pairs with nearly median centromeres, in their somatic complements. The longest and the shortest chromosome pairs present within the complement of T. purpurea are of 3.788 μ and 2.170 μ respectively. In contrast to this T. hamiltonii has longest chromosome pair of 4.188 μ and the shortest pair is of 1.666 μ. Satellited and secondarily constricted chromosomes are represented by a

Pl. 2:74

Tephrosia hamiltonii

Coll. No. 58 :

(Mitosis)

Fig. 357 - Camera lucida drawing of somatic metaphase plate.

Fig. 358 - Idiogram.

(Meiosis)

Fig. 359 - PMC showing 12 distinct bivalents at late diakinesis.

Figs. 360 and 361 - PMCs " 12 bivalents at metaphase I.

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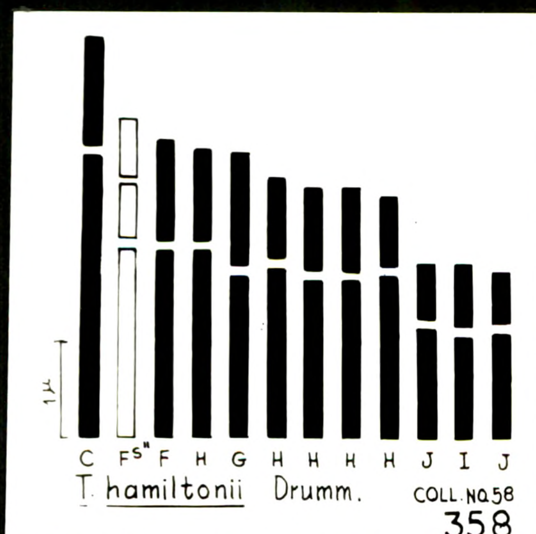

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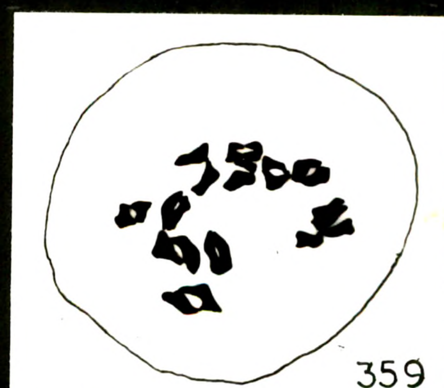
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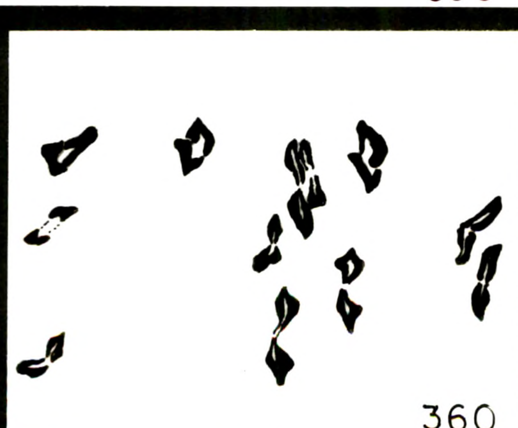
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PL. 2 : 74

Table 2:56. Details of the karyotype analysis of <u>Tephrosia hamiltonii</u> Drumm. (Coll. No. 58).

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	3.017	+	1.171	=	4.188	0.38	2.57	100	nsm	C
3, 4	2.027	+	0.585 + 0.631	=	3.243	0.59	1.66	77	nsm	$F^{S''}$
5, 6	1.981	+	1.081	=	3.062	0.54	1.83	73	nsm	F
7, 8	1.981	+	0.991	=	2.972	0.50	1.99	70	nsm	H
9,10	1.711	+	1.216	=	2.927	0.71	1.40	69	nm	G
11,12	1.801	+	0.856	=	2.657	0.47	2.10	63	nsm	H
13,14	1.666	+	0.901	=	2.567	0.54	1.84	61	nsm	H
15,16	1.666	+	0.901	=	2.567	0.54	1.84	61	nsm	H
17,18	1.711	+	0.765	=	2.476	0.44	2.23	59	nsm	H
19,20	1.171	+	0.585	=	1.756	0.49	2.0	41	nsm	J
21,22	1.081	+	0.675	=	1.756	0.62	1.60	41	nm	I
23,24	1.126	+	0.540	=	1.666	0.47	2.08	39	nsm	J
	20.939		10.898		31.837					

L/S = 2.51

Mean length = 1.33 μ

T F % = 34.23 %

Karyotype formula = $2n = 24 = C_2 + F^{S''}_2 + F_2 + G_2 + H_{10} + I_2 + J_4$

pair each in *T. purpurea*, while in *T. hamiltonii* shows the presence of only secondarily constricted chromosomes. Darkly stained B-chromosome observed in metaphase plates of *T. purpurea* are altogether in *T. hamiltonii*. The distinctness of the two karyotypes and their evolutionary status is clearly seen in the idiograms of the two species (Figs. 332 and 358). *T. purpurea* can be considered primitive than *T. hamiltonii*.

Observation of 12 distinct bivalents at diakinesis (Fig. 359) and at metaphase I (Fig. 360) confirms the 2n = 24. But for the presence of number of non congressional bivalents at metaphase I showing configuration of late diakinesis, no other abnormality is noticed. At later stages of meiosis also, behaviour is normal showing equal distribution of chromosomes. 94.15% is the value determined for the pollen fertility.

Psoralea L.

Psoralea corylifolia L.

A perusal of literature revealed that 4 species of Psoralea have been worked out for the chromosome numbers. Kreuter (1930) worked out 3 species and reported 2n = 20 for all of them. Recently Bakele & Sharma (1979) in their work have reported 2n = 22 for *Psoralea corylifolia* and at the same time they also report the existence of B-chromosome in the somatic complement and PMCs. In contrast to the above mentioned reports for the genus *Psoralea* in the present investigation 2n = 24 and n = 12 are the chromosome counts for somatic and gametic cells.

Coll. Nos. 7 and 51 :

(Coll. No. 7) $2n = 24 = G_2+H_{12}+I_2^S+I_6+J_2$

(Table 2:57)

(Coll. No. 51) $2n = 24 = G_2+H_8+I_2+J_{10}+K_2^S$

(Table 2:58)

Morphologically as well as cytologically both the collections tally with each other. The somatic complement of the species is characterised in having medium to short chromosomes ranging in length from 1.486 to 2.837μ(Coll. No. 7) and 1.306 to 2.882 μ (Coll. No. 51) chromosome pairs having nearly

Table 2:57. Details of the karyotyle analysis of <u>Psoralea corylifolia</u> L. (Coll. No. 7)

Chromosome pair	Length in μ Long Arm	+	Short Arm	=	Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.891	+	0.946	=	2.837	0.50	1.99	100	nsm	H
3, 4	1.711	+	1.081	=	2.792	0.63	1.58	98	nm	G
5, 6	1.621	+	0.856	=	2.477	0.52	1.89	87	nsm	H
7, 8	1.531	+	0.766	=	2.297	0.50	1.99	80	nsm	H
9,10	1.486	+	0.811	=	2.297	0.54	1.83	80	nsm	H
11,12	1.486	+	0.766	=	2.252	0.51	1.93	79	nsm	H
13,14	1.396	+	0.721	=	2.117	0.51	1.93	74	nsm	H
15,16	1.126	+	0.721	=	1.847	0.64	1.56	65	nm	I
17,18	1.081	+	0.675	=	1.756	0.62	1.60	61	nm	I^S
19,20	1.081	+	0.585	=	1.666	0.54	1.84	58	nsm	J
21,22	0.991	+	0.675	=	1.666	0.68	1.46	58	nm	I
23,24	0.811	+	0.675	=	1.486	0.83	1.20	52	nm	I
	16.212		9.278		25.490					

L/S = 1.90

Mean length = 1.06 μ

T F % = 36.39%

Karyotype formula : $2n = 24 = G_2 + H_{12} + I_2^S + I_6 + J_2$

Table : 2:58. Details of the karyotype analysis of Psoralea corylifolia L. (Coll. No. 51).

Chromosome pair	Length in μ Long Arm	+ Short Arm	= Total length	Arm Ratios R_1	R_2	Relative length	Centromere	Type
1, 2	1.891	+ 0.991	= 2.882	0.52	1.90	100	nsm	H
3, 4	1.486	+ 0.946	= 2.432	0.63	1.57	84	nm	G
5, 6	1.576	+ 0.811	= 2.387	0.51	1.94	82	nsm	H
7, 8	1.576	+ 0.766	= 2.342	0.48	2.05	81	nsm	H
9,10	1.351	+ 0.766	= 2.117	0.56	1.76	73	nsm	H
11,12	1.486	+ 0.496	= 1.982	0.33	3.0	68	SM	K^S
13,14	1.261	+ 0.721	= 1.982	0.57	1.74	68	nsm	J
15,16	1.351	+ 0.585	= 1.936	0.43	2.30	67	nsm	J
17,18	1.261	+ 0.631	= 1.892	0.50	1.99	65	nsm	J
19,20	1.126	+ 0.676	= 1.802	0.60	1.66	62	nsm	J
21,22	0.941	+ 0.676	= 1.617	0.71	1.39	56	nm	I
23,24	0.856	+ 0.450	= 1.306	0.52	1.90	45	nsm	J
	16.162	8.515	24.677					

L/S = 2.20

Mean Length = 1.02 μ

T F % = 34.50 %

Karyotype formula = $2n = 24 = G_2 + H_8 + I_2 + J_{10} + K^S_2$

Table 2:59. Comparison of the somatic chromosomes of populations of *Psoralea corylifolia* L.

Populations	Somatic number (2n)	n m Types G	n m Types I	S M K	n s m Types H	n s m Types J	Chromosome with satellite K^S	Chromosome with satellite I^S	Absolute length in μ	Mean length in μ	L/S
51	24	2	2	2	8	10	2		24.677	1.02	2.20
07	24	2	8	-	12	2		2	25.490	1.06	1.90

Pl. 2:75

Psoralea corylifolia

Coll. No. 7 :

(Mitosis)

Fig. 362 - Camera lucida drawing of somatic metaphase plate.

Fig. 363 - Idiogram.

Fig. 364 - Photomicrograph of somatic metaphase plate.

Coll. No. 51 :

Fig. 365 - Camera lucida drawing of somatic metaphase plate.

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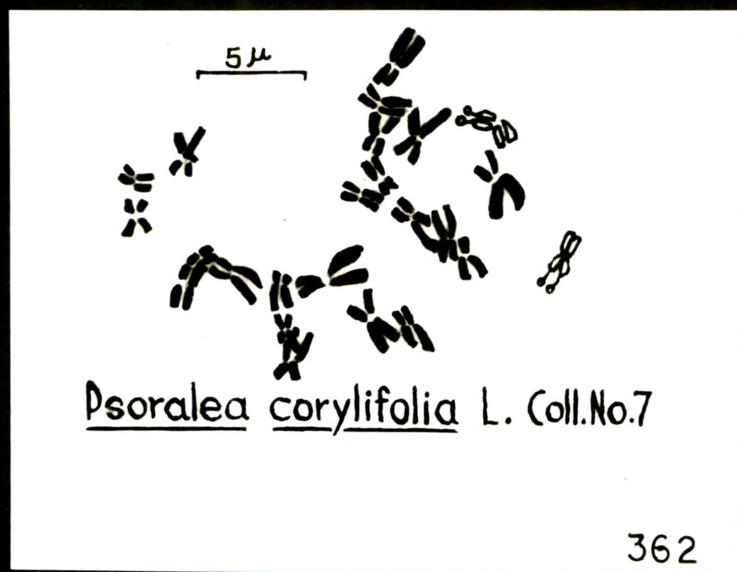

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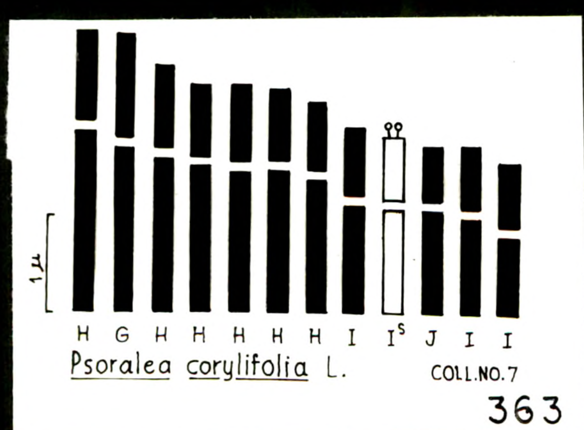

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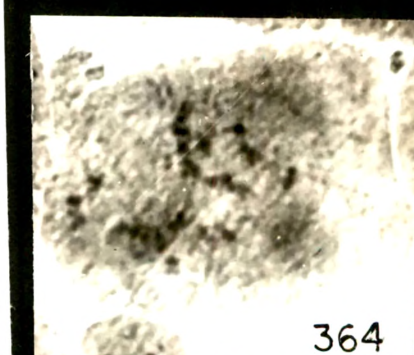

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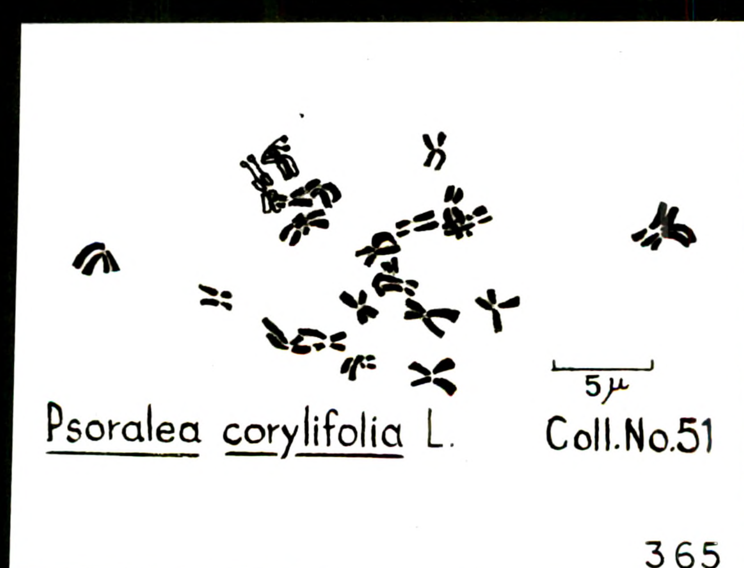

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PL. 2 : 75

Pl. 2:76

Psoralea corylifolia

Coll. No. 51 (Contd.) :

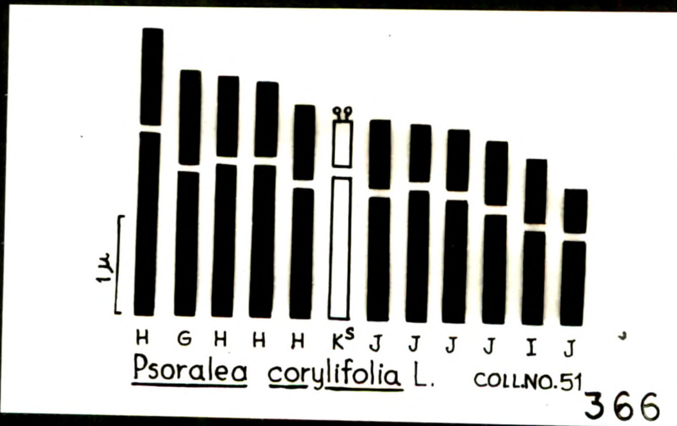
(Mitosis)

Fig. 366 - Idiogram.

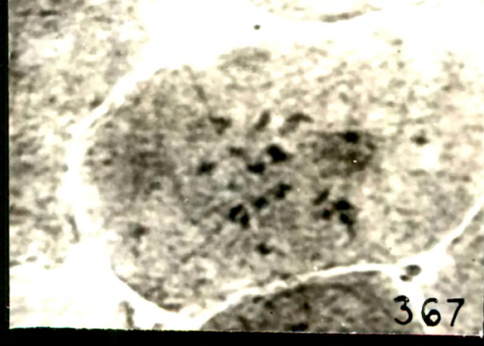
Fig. 367 - Photomicrograph of somatic metaphase plate.

(Meiosis)

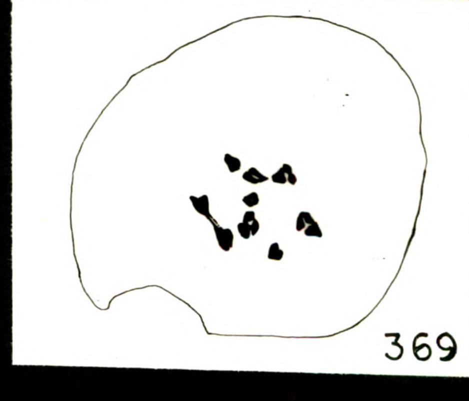
Figs. 368 and 369. - PMC showing 12 bivalents at early and late diakinesis.



366


367


368


369

PL. 2 : 76

submedian centromeres are represented by H & J-types while, those with nearly median are represented by G & I-types. Coll. No. 51 has a pair of chromosome with submedian centromere which is also satellited one (K^S-type). Coll. No. 7 also contains a pair of satellited chromosome (I^S-type) which is having nearly median centromere (Figs. 362, 363, 364 and 365, 366, 367).

B-chromosomes reported by Bakele & Sharma (1979) are not observed in the present study. Comparison of the idiograms of the two populations reveal that Coll. No. 7 is slightly more abruptly graded in the initial stage while Coll. No. 51 is having more or less smooth gradation. As can be seen from the respective tables (2:57, 2:58 and 2:59) values of L/S ratio, TF% and mean length of the chromosomes for the somatic complements of the two collections are not at great variance.

A study of meiotic behaviour revealed the presence of 12 bivalents at diakinesis (Fig. 368). At metaphase I some of the PMCs showed precocious movement of few bivalents while, in majority of the PMCs studied showed regular metaphase plate having bivalents organised in the usual manner. At late diakinesis secondary groupings of bivalents are noticed (Fig. 369). The pollen fertility determined for the species is very high (99.29%).

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M I C R O M O R P H O L O G I C A L

O B S E R V A T I O N S

S O L A N A C E A E

MICROMORPHOLOGICAL OBSERVATIONS

In recent past 'leaf' has attracted the attention of many researchers and as a result of that, good deal of angiospermic plant groups have been studied for various characters.

In the present investigation of selected taxa of Solanaceae and Fabaceae, epidermal cells, stomata, trichomes and venation pattern details, have been studied.

Abbreviations used in the explanation of various figures of micromorphological observations are as follow.

L.S.	-	Lower surface	CCS	-	Cuticular striations
U.S.	-	Upper surface	CC	-	Cytoplasmic connections.
Anom.	-	Anomocytic stomata	CS	-	Contiguous stomata
Para.	-	Paracytic stomata	ec	-	Extension cell.
Aniso.	-	Anisocytic stomata	bs	-	Bundle sheath.
SSC	-	Stomata with single subsidiary cell.	iv	-	Isolated vein.
DGC	-	Stomata with degenerating guard cell.	it	-	Isolated trachied
SGC	-	Stomata with single guard cell.	l	-	loop.
PSC	-	Persistent stomatal cell.			

Nicandra physalodes (L.) Gaertn.

Epidermal cells on both the surfaces are either polygonal or slightly elongated. The anticlinal walls of the epidermal cells are irregularly sinuous. The cell frequency per mm^2 and length & breadth of cell 384 & 464 and 98 x 47 μ and 75 x 36 μ (Table 3:1) are recorded for the lower and upper surfaces respectively. Leaves are sparsely clothed with trichomes. Eglandular conical uniseriate and glandular long uniseriate stalked with unicellular head are more commonly seen. The short stalked with multicellular head, glandular type are of rare occurrence and are not observed by earlier workers (Table 3:2). The percentage distribution of stomatal type is : anomocytic 31%; paracytic, 24%; anisocytic, 35% and stomata with single subsidiary cell, 10% (Table 3:4). The values for stomatal frequency per mm^2 and index recorded for lower and upper surfaces are 128 & 96 and 25 & 17. Differences in the size of guard cell are not marked for the two surfaces (Table 3:3). Stomatal abnormalities, such as contiguous stomata, stomata with single guard cell and degeneration of guard cell or cells are occasionally observed in few epidermal peels (Fig. 3:3 -A,B).

The basic venation pattern of the leaf is pinnate camptodromous. Secondaries showed festooned brochidodromous type of venation pattern (Pl. 3:9 - C). Intersecondaries interspersed between the secondaries, on one or both the sides of midrib are noted. Areoles are mostly polygonal or articulate in shape (Pl. 3:11 -B, E). One areole per mm^2 having an average size 1.0 mm^2 with absolute veinislet number in thousands, 1.340 are recorded. As many as 15 veinlets are noticed entering areoles per mm^2. Veinlets are once or twice dichotomously branched and mostly have curved course (Pl. 3:11 -B, C). Veinending terminations per mm^2 30 and absolute vein terminations number in thousands 40.200 are determined (Table 3:5). Occasionally, loop formation by ultimate veins, with or without trachieds is observed.

Lycium _barbarum_ L.

The epidermal cells are quadrangular or polygonal shaped with straight and arched anticlinal walls. 640 & 720 are the epidermal cell frequency per mm^2 and 52 x 34 μ and 49 x 32 μ, average cell sizes determined for the lower and upper surfaces respectively. Leaves are clothed with only a few eglandular uniseriate filiform type of trichomes (Table 3:2). Anomocytic, paracytic and anisocytic types of stomata are observed. The percentage count of above mentioned types for the lower surface of leaf is 58%; 17% and 25% respectively. The subsidiary cells of paracytic type of stomata observed, are mostly non contiguous at both poles (Fig. 3:3 - D), while the subsidiary cell of stomata with single subsidiary cell is parallel to its longitudinal axis (Fig. 3:3 - C). The stomatal frequency per mm^2 and stomatal index for the lower and upper surfaces are comparable (Table 3:3). Values of guard cell size 23 x 07 μ and 32 x 10 μ are determined for the two surfaces. Arrested development of stomata, cuticular striations radiating from guard cells (Fig. 3:3 - D) are the two abnormalities recorded.

Like the preceding species, festooned brochidodromous venation pattern is observed. The highest degree of vein order observed is upto 5°. One areole/mm^2 having an average size of 1.0 mm^2 is recorded. Absolute veinislet number in thousands determined for the species is 0.065. Veinlets are mostly branched having linear or curved path. On an average 10 veinlets and 20 veinterminations per mm^2 and absolute vein terminations in thousands 1.300 are recorded (Table 3:5).

<u>Withania somnifera</u> (L.) Dun.

The epidermal cells observed on both the surfaces are not of any regular shape. Among the 5 genera studied, this taxon resembled <u>Lycium</u> in having straight and arched nature of anticlinal walls. 464 & 1040 and 53 x 23 μ & 48 x 19 μ

are the respective values determined for epidermal cell frequency per mm^2 and cell size for the lower and upper surfaces (Table 3:1). Both the types of trichomes recorded, are of eglandular nature. Branched candelabra (Fig. 3:2 -I), type of trichomes thickly covered the leaf surfaces, while stellate trichomes are rarely met with (Table 3:2). In this species the percentage distribution of paracytic stomata is slightly more i.e. 37%, while anomocytic, anisocytic and stomata with single subsidiary cell types are represented by 25, 28 and 10 per-cents respectively (Table 3:4).

The values for the size of guard cells, stomatal index and frequency per mm^2, determined for the two surfaces showed significant differences (Table 3:3). Stomata with single guard cell and degeneration of guard cell or cells, are seen occasionally (Fig. 3:5 - H).

In this species also the basic pattern gets modified to form festooned brochidodromous, by formation of secondary loops. Intersecondaries are occasionally observed in intercostal region. 3 well defined areoles per mm^2 are of 0.33 mm^2 average size each. The calculated absolute veinislet number, for the species, in thousands is found to be as high as 3.696. Veinlets are comparatively thick, simple or branched. 30 veinlets and 45 veinterminations are observed per mm^2 area of areoles. 55.440 is the determined absolute vein termination number in thousands. All the major and minor degrees of veins, including vein endings are jacketed by parenchymatous bundle sheath.

Physalis longifolia Nutt.

The epidermal peel study revealed the presence of more or less the same shaped epidermal cells. The sinuousites of anticlinal walls are not well defined on both the surfaces. Epidermal cell frequency for the two surfaces showed little difference, 688 for lower surface and 640 for upper surface. Cell size determined for the lower and upper surfaces are 118 x 45 µ and 107 x 23 µ respectively (Table 3:1). But for the occasional occurrence eglandular conical uniseriate trichomes, the long uniseriate stalked with unicellular head type of glandular hair are common (Table 3:2). The study of stomatal types revealed the presence of a rare type of stomata, the hemidiacytic, constituting 1% of the total count. Other 2 types, anomocytic and anisocytic, observed showed the percentage distribution of 68% and 31% respectively (Table 3:4). Total absence of paracytic type of stomata is a noteworthy feature. The stomatal frequency per mm^2 and stomatal index recorded, are 112 & 14 for the lower surface and 80 & 11 for the upper surface. The guard cell size values are 28x 10 µ and 31 x 09 µ for lower and upper surfaces respectively(Table 3:3).

Some of the anomocytic stomata present on the abaxial side of leaf appeared giant sized (Fig. 3:3 - E). But for a few degenerating guard cells, no abnormality is noticed in the structure of mature stomata.

Venation pattern, in general, is of pinnate camptodromous type. The secondaries, near the margin upturn and join superadjacents forming brochidodromous type of venation. Intersecondaries are commonly observed on both the sides of midrib. Highest degree of vein order observed is upto 6°. Areoles are articulate or quadrangular in general outline (Pl. 3:11 - D). Average size of an areole is 0.5 mm^2. 2 areoles per mm^2 having absolute veinislet number in thousands, 0.997 are determined for the species. Veinlets entering the areoles, are either simple or branched. The number of veinlets entering areoles/mm^2 is 18, while the counts for veinending terminations/mm^2 and absolute vein terminations number in thousand are 50 and 49.850 respectively (Table 3:5). The parenchymatous bundle sheath jacketing veins of all the degrees is noticed.

Physalis minima L.

Epidermal cells showed sinuous course of anticlinal walls. The size difference in cells of two surfaces is quite evident. The epidermal frequency per mm^2 for abaxial and adaxial surface showed marginal difference (288 and

272 respectively, Table 3:1). Of the two types of trichomes observed, glandular long uniseriate stalked with unicellular head are more common, while, eglandular conical uniseriate ones are scarce (Table 3:2). Epidermal peels study showed the presence of four types of stomata. The per cent distribution of these types is anomocytic 31%, anisocytic 44%, paracytic 17% and stomata with single subsidiary cell 8% (Table 3:4). The length & breadth of guard cells 23 x 09 µ and 19 x 07 µ, stomatal index 35 & 10 and stomatal frequency per mm^2 160 & 32 are recorded for lower and upper surfaces respectively (Table 3:3). A number of abnormalities concerning the structure and development of stomata are observed. The presence of persistent stomatal cell, notching of the guard cells, stomata with single guard cell and amitotic division of guard mother cell nucleus are noteworthy (Fig. 3:3 - G; Pl. 3:7 - A, E, F, G).

Leaf showed festooned brochidodromous venation, which represents a modified pinnate camptodromous type of basic venation pattern. Intersecondaries arising from the primary vein are present either on one or both sides of the lamina. Areoles are more or less rectangular having the average size of 1.0 mm^2. The quantitative data relating to number of areoles per mm^2 and absolute veinislet number in thousands for the species are presented in table 3:5. On an average 6 veinlets are noticed entering areoles per mm^2. Veinlets are simple or branched and linear or curved (Pl. 3:11 - D). Vein ending terminations per mm^2 and absolute vein termination number in thousands determined are, 8 and 3.024 respectively (Table 3:5). Associated with the vein-endings, biseriate trachieds are also observed occasionally (Pl. 3:13 - G).

Solanum villosum Mill. subsp. villosum

Epidermal cells of both the surfaces are irregularly elongated with sinuous anticlinal walls. The lowest frequency (144) of epidermal cells per mm^2 amongst the Solanum species studied, is noticed on the abaxial surface of leaf of this species. Length and breadth of epidermal cell 76 x 50 μ and 82 x 32 μ (Table 3:1) are recorded for lower and upper surface, respectively. Eglandular unicellular and glandular long uniseriate stalked with unicelled head type of trichomes are observed on both the surfaces (Table 3:2). Three types of stomata viz., anomocytic (12%), paracytic (15%), and anisocytic (73%) are noticed (Table 3:4). The stomatal frequency 96 & 33 per mm^2, stomatal index 40 & 25 are determined for the lower and upper leaf surface respectively. The differences in the length & breadth of guard cell are negligible, for the two surfaces (Table 3:3). Stomata with single guard cell and degeneration of guard cell and degeneration of guard cell or cells (Fig. 3:3 - I, J), are the only 2 abnormalities noticed in peel study.

General venation pattern seen is festooned brochidodromous type. Secondary veins have sinuous course. Highest degree of vein order observed is upto 5°. Areoles with variable shapes, showed an average size of 1 mm^2. Number of areoles per mm^2, recorded is 1, with 0.320, absolute veinislet number in thousands. As many as 15 veinlets are noticed entering the areoles per mm^2. These are simple or branched and linear or curved. Absolute vein termination number in thousands 7.062, is calculated for the species. All the degrees of veins are noticed to be jacketed by parenchymatous bundle sheath.

Solanum villosum Mill. subsp. puniceum (Kirschleger) Edmonds

The polygonal and elongated epidermal cells are without prominent sinuousites of the anticlinal walls. The two surfaces of the leaf, abaxial and adaxial showed difference in epidermal cell frequency per mm^2 and also in cell size (Table 3:1). Leaves showed eglandular unicellular type of trichomes with interspersed glandular, long uniseriate stalked with unicellular head ones. Three types of stomata viz., anomocytic, paracytic and anisocytic are distributed in 29, 6, 65 per-cents respectively. The stomatal frequency per mm^2 determined for abaxial surface is 80 and for adaxial surface it is 48. The numerical data pertaining to stomatal index, size of guard cells, for the two surfaces, showed slight difference (Table 3:3). Abnormal giant sized stomata and degeneration of guard cell or cells are observed in few peels (Fig. 3:3 - K).

Like the preceding one, in this species also festooned brochidodromous type of venation is noticed. Intersecondaries, interspersed between the secondaries are occasionally observed. More or less polygonal areoles showed an average size of 0.5 mm^2. Usually 2 areoles cover per mm^2 area of leaf. Absolute veinislet number in thousands determined for the areoles is 0.900. Veinlets are more or less unbranched showing linear or curved course. In contrast to the preceding species as many as 26 veinlets are counted entering the areoles per mm^2. Absolute vein termination number in thousands calculated for the species is 13.500 (Table 3:5).

Solanum chenopodioides Lam.

Epidermal cells, on adaxial and abaxial surfaces are polygonal or quadrangular with irregularly sinuous anticlinal walls. The size of epidermal cell and cell frequency per mm^2 determined for the two surfaces showed only marginal difference (Table 3:1). Trichomes are uniformly distributed on both the sides of leaf. Two types of eglandular trichomes recorded are, simple unicellular and simple uniseriate filiform.

The recorded percentage distribution of four stomatal types is : anomocytic 35%, paracytic 5%, anisocytic 55% and stomata with single subsidiary cell 5%. Invariably the two subsidiary cells of paracytic stomata are contiguous at both poles, while single subsidiary celled stomata has its subsidiary cell lying parallel to the pore (Fig. 3:4 - A). 112 & 80 and 26 & 20 and 33 x 09 µ & 26 x 09 µ are the numerical values recorded for stomatal frequency per mm^2, stomatal index and size of the guard cell for abaxial and adaxial sides respectively (Table 3:3). A few peels showed occasional degeneration of guard cell or cells (Fig.3:4 - A).

The species depicted a well defined festooned brochidodromous type of venation. The highest degree of vein order traced is 6°. Rectangular and polygonal areoles having an average size of 0.5 mm^2 are recorded. Usually 2 areoles occupied per mm^2 area and the absolute veinislet number in thousands, determined is 0.920. Veinlets entering areoles, are mostly without further ramifications. On an average 20 veinending terminations per mm^2 are seen. Other relevant quantitative data are presented in table 3:5. Presence of extension cell (Pl. 3:13 - D) and uniseriate trachied (Pl. 3:13 - F) in the areole, are the two noteworthy features of this species. Like the preceding species all the degrees of veins are seen jacketed by bundle sheath.

Solanum scabrum Mill.

The general outline of the epidermal cells is loosely sinuous. The quantitative data concerning the epidermal cell frequency per mm^2 and cell size determined for the abaxial and adaxial sides showed marked difference (Table 3:1). Leaf surfaces are sparsely clothed with hairs. Two types of trichomes observed are : eglandular stellate and glandular long uniseriate stalked with unicellular head. Of the two types, stellate type is less frequent than the other type. Four types of stomata, anomocytic, paracytic, anisocytic and stomata with single subsidiary cell are represented by 18, 15, 57 and 10 per cent respectively. The subsidiary cells of paracytic stomata are mostly noncontiguous at both the poles (Fig. 3:4 - C). Stomatal frequency per mm^2 and stomatal index determined for the two surfaces are quite variable (Table 3:3), while the guard cell size determined is almost the same i.e. 24 x 09 μ for lower surface and 26 x 09 μ for the upper surface. Quite a few abnormalities such as, persistent stomatal cell, one and half contiguous stomata, degeneration of guard cell or cells (Fig. 3:4 - B, C, D) are recorded.

Like other species of Solanum studied this species also showed festooned brochidodromous type of venation. In this case secondaries are alternately disposed and inter-secondaries are interspersed between them (Pl. 3:8 - B).

Tertiary veins formed orthogonal reticulate configurations. Areoles formed by all categories of veins are rectangular or quadrangular (Pl. 3:10 - D), having an average size of 0.5 mm^2. Absolute veinislet number in thousands calculated for the species is 4.450. The veinlets entering the areoles are invariably simple having linear or curved path. Vein endings occasionally formed loops within an areole (Pl. 3:12 - A, B). Data concerning number of areoles, veinlets entering areoles, veinending terminations per mm^2 and absolute vein termination number in thousand are presented in table 3:5. All the degrees of veins are noticed to be jacketed.

<u>Solanum</u> <u>americanum</u> Mill.

Polygonal or isodiametric epidermal cells, showed more or less regular sinuousites of anticlinal walls.The epidermal cell frequency per mm^2 and size of the cell recorded for the species are 336 & 368 and 84 x 22 μ and 109 x 32 μ for the lower and upper surface respectively. Glandular long uniseriate stalked with unicellular head type of trichomes are more common, while the stellate hairs are seen rarely. Among the stomatal types observed, anisocytic type of stomata are predominant, represented by 75%. Total absence of paracytic stomata is worth recording for the species (Table 3:4). 160 & 48 and 32 & 11 are the values determined for stomatal frequency per mm^2 and stomatal index for the lower and upper surfaces respectively. Size of the guard cells for the two surfaces is more or less the same (Table 3:3). Only stomatal abnormality recorded is the presence of stomata with single guard cell (Fig.3:4-D,E).

The basic pinnate camptodromous venation pattern gets modified to form festooned brochidodromous type. The tertiaries form orthogonal reticulate pattern of areolation. Highest degree of vein identified is upto 6°. The average areole size 1.0 mm^2 and absolute veinislet number in thousand 1.230 are calculated for the species. As many as 10 veinlets entering the areoles are seen, which are once or twice dichotomously branched. This is ascertained by the number of veinending termination for same unit area i.e. 26. Absolute vein termination number in thousands determined for the species is 31.980 (Table 3:5).

<u>Solanum</u> <u>roxburghii</u> Dun.

The cells of the epidermis are usually polygonal and elongated but very rarely isodiametric. Infrequent occurrence of straight anticlinal walls, representing extensions of loose sinuousites is worth noting (Fig. 3:4 - F). Epidermal cell frequency per mm^2 for the abaxial and adaxial surfaces differ considerably, while the cell size remained more or less same as same is evident by determined cell size (Table 3:1). Both the surfaces of leaves are sparsely covered with only eglandular simple uniseriate type of trichomes. The percentage distribution of different types of stomata recorded is, anomocytic 22%, paracytic 11%, anisocytic 57% and stomata with single subsidiary cell 10%. Two subsidiary cells of paracytic stomata are mostly contiguous at one pole (Fig. 3:4 - G). Moreover, giant sized anomocytic stomata (Fig. 3:4 - F) are occasionally seen.

Like the preceding species, the differences in determined values of stomatal frequency per mm^2 and index are marked (Table 3:3). Average values of length and breadth of guard cell for lower and upper epidermis are 31 x 10 µ & 27 x 09 µ respectively.

In this species festooned brochidodromous type of venation pattern is characterised in having sub-opposite secondaries and intersecondaries interspersed between them (Pl. 3:9 - B). Highest degree of vein order identified is upto 5°. Triangular and polygonal areoles (Pl. 3:11 - A,F) present are of 0.5 mm^2 average size. Usually 2 areoles are recorded per mm^2. Vein endings in an areole are mostly branched. Among the species of Solanum studied presently the highest number of veinlets entering areoles, 30 per mm^2 area is recorded for the species. The other quantitative data pertaining to vein ending termination per mm^2 and absolute vein termination number in thousands are presented in table 3:5.

Solanum purpureilineatum Sabnis & Bhatt

The general shape and contour of the epidermal cells in all essentials resembled with those of S. roxburghii. The difference between the epidermal cell frequency per mm^2 for the abaxial and adaxial surfaces is marginal. Epidermal cells showed variation in their sizes. 92 x 36 μ & 117 x 48 μ are the sizes determined for lower and upper surfaces respectively (Table 3:1). Eglandular simple filiform trichomes, moderately covered both the leaf surfaces (Table 3:2). Four types of stomata are seen. The percentage distribution of each type determined is : anomocytic 20%, paracytic 12%, anisocytic 58% and stomata with single subsidiary cell 10%. The stomatal frequency per mm^2 82 & 48, and stomatal index 20 & 13 are recorded for the abaxial and adaxial leaf surfaces respectively. Largest sized guard cells, amongst the taxa studied presently, are occasionally noticed on the lower surface (Table 3:3). The subsidiary cells, flanking paracytic stomata are non-contiguous at both the poles. Degeneration of guard cell or cells is also noticed (Fig. 3:4 - H, I).

The species showed well defined festooned brochidodromous type of venation pattern. Occasionally intersecondaries are seen in the intercostal regions. Highest degree of vein order observed is upto 6°. Rectangular or polygonal areoles of 1.0 mm^2 average size are noticed. Absolute veinislet number in thousands, 3.025 is recorded for the species. Veinlets are forked once or twice. 17 veinlets entering areoles per mm^2 area showed as many as 40 vein ending terminations for the same area (Pl. 3:12 - E). Absolute vein termination number recorded in thousands is found to be quite high (Table 3:5). Isolated vein and free vein endings lying in mesophyll are seen frequently (Pl. 3:13 - A, B, C).

Solanum nodiflorum Jacq.

The anticlinal walls of the epidermal cells have narrow sinuousites on the lower surface while loose and broad sinuousites are noted for upper surface. The epidermal cell frequency per mm^2 and cell size 352 & 176 and 120 x 49 μ & 108 x 26 μ are determined for abaxial and adaxial leaf surfaces. The above presented data points towards the distinctness of the two surfaces. Only eglandular conical uniseriate type of trichomes are seen on the two surfaces. Anomocytic, paracytic, anisocytic and stomata with single subsidiary cell are distributed in 17, 14, 65 and 4 per cent respectively. Stomatal frequency per mm^2 and stomatal index for the two surfaces viz., abaxial and adaxial are 128 & 32 and 26 & 15 respectively. Average size of the guard cell of the two surfaces does not show much variation (Table 3:3). Subsidiary cells of paracytic stomata are contiguous at both the poles (Fig. 3:4 - K). In stomata with single subsidiary cell, the subsidiary cell is parallel to the longitudinal axis of guard cell (Fig. 3:4 - J, K). Degenerating guard cell or cells are also observed.

The sub opposite secondaries arising from the primary vein, are responsible for constituting festooned brochidodromous venation pattern. The vein order upto 6° could be traced for the species. Intersecondaries are scarcely observed. Areoles are mostly polygonal having an average size of 0.5 mm^2. The calculated absolute veinislet number in thousands is 3.020. For one unit area of leaf (1 mm^2) 22 veinlets entering areoles and 56 vein ending termination are recorded. These values clearly indicate that veinlets are more than once forked. The higher value i.e. 84.560, of absolute vein termination number in thousands is in coherence with the other qualitative data concerning venation pattern (Table 3:5).

<u>Solanum</u> <u>nigrum</u> L.

The quadrangular epidermal cells are with irregular but prominent sinuousites. As compared to other species, in this species the average cell size is 60 x 22 μ for the lower surface and 68 x 23 μ for upper surface. The epidermal cell frequency per mm^2 values determined for the abaxial and adaxial surfaces are 368 & 480 respectively (Table 3:1). Along with usual type glandular long uniseriate stalked with unicelled head, eglandular stellate type of trichomes, are also recorded less frequently on the leaf surfaces (Table 3:2). 21%, 27%, 46% and 6% are the respective values for distribution of anomocytic, paracytic, anisocytic and stomata with single subsidiary cell type. The average size of guard cells, 24 x 07 μ & 17 x 06 μ, stomatal frequency per mm^2, 192 & 112 and stomatal index 34 and 19 determined for the lower and upper surfaces, depicted marked difference (Table 3:3). No stomatal abnormality is recorded for the species.

In this species the venation pattern differs from others in its having fimbriate marginal ultimate venation. Alternately placed secondaries are occasionally accompanied by intersecondaries (Pl. 3:8 - C). Veins of 3rd order form orthogonal reticulate venation pattern because their angles of anastmoses are predominantly at right angles. Calculated values for the average size of areole in mm^2, number of areoles per mm^2 and absolute veinislet number in thousands are: 0.5 mm^2, 2 and 1.790 respectively. Both forked and simple veinlets having linear or curved path are noticed. Data concerning number of veinlets entering areoles per mm^2, vein ending terminations per mm^2 and absolute vein termination number in thousands are presented in table 3:5.

<u>Solanum</u> <u>nigrum</u> L. (Red veined form)

Epidermal cells are variable in shape. The average size determined for the cells of lower surface is 93 x 35 μ and it is 117 x 38 μ for upper surface. Epidermal cell frequency per mm^2 is 256, for the abaxial surface and 192 for the adaxial surface (Table 3:1). Of the 2 types of glandular and one type of eglandular observed, eglandular stellate and glandular short stalked with multicellular head (Fig. 3:2 - L), are of rare occurrence (Table 3:2). 3 types of stomata viz., anomocytic, anisocytic and stomata with single subsidiary cell are observed. Paracytic are conspicuous by their total absence. Anisocytic stomata are more in number i.e. 76%, while anomocytic are represented by 20% and stomata with single subsidiary cell are represented by 4% only(Table 3:4). Guard cell size for the two surfaces are more or less the same, while the stomatal frequency per mm^2 and stomatal index for the abaxial and adaxial surfaces differed greatly (Table 3:3). Structural as well as developmental stomatal abnormalities such as, stomata with single guard cell (Pl. 3:7 - D) and uni and binucleate persistent stomatal cells (Pl. 3:7-B,C) are noticed.

In this species venation, in its basic pattern, resembled that of the type species, <u>S</u>. <u>nigrum</u>. Tertiary veins anastomoses are responsible for the formation of orthogonal reticulate type of venation. Numerical data pertaining to average size of areole, number of areoles per mm^2 and veinislet number in thousands are presented in Table 3:5. On an average 8 veinlets and 14 vein-ending terminations per unit area of areoles are observed. Loop formation within an areole takes place by anastomosing of vein terminations which are long and curved. Absolute vein termination number in thousands, 9.520 is determined for the species.

Solanum viarum Dun.

Epidermal cells are mostly quadrangular or polygonal in shape. Sinuousites of the anticlinal walls of abaxial surface are prominent than that of adaxial surface (Fig. 3:5 - B, C). Difference in the epidermal cell size for the two surfaces is negligible, while cell frequency per mm^2 is 528 for the lower surface and 448 for the upper surface (Table 3:1). Of the 3 types trichomes observed, eglandular unicellular and glandular long uniseriate stalked with unicellular head, are more common than eglandular simple uniseriate filiform type. Anomocytic, paracytic, anisocytic and stoma with single subsidiary cell type, of stomata are distributed in 16%, 14%, 67% and 3% respectively (Table 3:4). The grouping of stomata, non-contiguous nature of subsidiary cells of paracytic stomata (Fig. 3:5 - B) and parallel orientation of subsidiary cell of the stomata with single subsidiary cell (Fig. 3:5 - C), are noteworthy features. The sparse distribution of stomata on upper surface is evidenced by the determined stomatal frequency per mm^2, 80 & stomatal index, 15 (Table 3:3). Degeneration of guard cell or cells and stomata with single guard cell are the only two abnormalities observed.

Basic venation pattern observed in other species of Solanum is seen in this species also. Highest degree of vein order noticed is 5°. 2 well defined areoles of 0.5 mm^2/unit area of the leaf are seen. 22 veinlets entering areoles and 28 veinlet terminations per unit area of the leaf are recorded with 1.300 and 15.800 as the respective values in thousands for absolute veinislet number and absolute veinlet termination number (Table 3:5).

Solanum trilobatum L.

Slightly more elongated cells did not show well defined sinuousites. Epidermal cell size and frequency per mm^2 determined for the two surfaces are greatly variable (Table 3:1). Sparsely distributed, eglandular stellate trichomes are commonly observed on the two surfaces. Amongst the stomatal types observed, anisocytic claimed highest percentage i.e. 63% and anomocytic and paracytic are represented by 25% and 12% respectively. Low values of stomatal index i.e. 10 & 06 and stomatal frequency per mm^2, 112 & 48 for lower and upper surfaces respectively, clearly indicate that the stomata are distantly distributed on both the surfaces (Table 3:3; Fig. 3:5 - D, E). Cytoplasmic connections between the guard cells of adjoining stomata (Fig. 3:5 - D), juxtaposed or super imposed nature of contiguous stomata (Pl. 3:7 -H,I), degeneration of guard cell or cells and stomata with single guard cell (Fig. 3:5 - E) are noticed in a few epidermal peels.

The basic venation pattern agreed with other species of Solanum in many respects. However, the highest vein order upto 6° is identified. Areoles are mostly regular showing 1.0 mm^2 average size. Veinislet number in thousands calculated for the species is 1.175. Veinlets are simple or once divided. 8 veinlets and 13 vein ending terminations per mm^2 areoles are observed. 15.275 figure is recorded as the absolute vein terminations in thousands. A few veinlets lying free in the areole are noticed (Pl. 3:12 - C).

Solanum heterodoxum Dun.

The anticlinal walls of the epidermal cells are more or less straight and arched (Fig. 3:5 - F) on the lower surface while, they are sinuous on the upper surface. The data for the epidermal cell size and cell frequency per mm^2 for the two surfaces showed some variations (Table 3:1). Glandular long uniseriate stalked with unicellular head type of trichomes are uniformly distributed on both the surfaces. Anisocytic type of stomata though predominant, are represented by 55% only. Other types viz., anomocytic, paracytic and stomata with single subsidiary cell are represented by 29, 10 and 6 per cent respectively (Table 3:4). Values for stomatal frequency per mm^2, stomatal index and size of the guard cell, calculated for the abaxial and adaxial surfaces are more or less the same (Table 3:3). Degeneration of guard cell or cells and cuticular thickenings in the form of small pads at the polar junctions (Fig. 3:5 - G) are the two abnormalities recorded for the species.

Leaves are deeply dissected in pinnate fashion. Though leaves are deeply dissected in pinnate fashion, the basic venation pattern observed is same, as in other Solanums i.e. pinnate camptodromous. Secondaries, innervating the lobes, follow a sinuous course (Pl. 3:10 - F & Pl. 3:12 - D). Areoles have well quadrangular or polygonal shape. 3 areoles per mm^2 of 0.33 mm^2 average size are observed. 27 vein endings and 42 vein ending terminations per mm^2 area of areoles are recorded. Absolute vein islet number and absolute vein termination number in thousands are 1.434 and 20.076, respectively. Veins of all orders are jacketed by bundle sheath.

F A B A C E A E

Tephrosia strigosa Dalz.

The epidermal cell frequency per mm^2 672 & 1008 and cell size 39x26 μ & 43x20 μ, for abaxial and adaxial leaf surfaces, are recorded. 3 types of stomata viz., anomocytic, paracytic and anisocytic, are distributed in 15, 60 & 25 per cent respectively. The subsidiary cells of paracytic stoma are either contiguous or non-contiguous at one or both the poles (Pl. 3:5-J,K). Stomatal frequency values 320 & 192 and index values 32 & 24 are determined for lower and upper surfaces. These values for the two surfaces vary considerably. Average guard cell size 20x08 μ for the lower surfaces and 18x06 μ for the upper surface, are determined.

The leaf is simple and shows pinnate camptodromous type of venation, without prominent intramarginal arches. Number of secondaries, on either side of mid vein range between 18 to 20. These secondaries move towards the margin almost parallel to each other and then upturn to join superadjacents to form brochidodromous venation pattern. Highest degree of vein order observed is upto 4°. Areoles are mostly rectangular, small, of 0.20 mm^2 average size. As many as 30 veinlets are seen entering areoles per mm^2 area. The determined vein ending termination number per mm^2 indicates that the number of veinlets entering an areole is variable (Table 3:9). Veins, veinlets and trachieds in various combinations are involved in loop formation (Pl. 3:16-A). Absolute vein islet number and absolute vein termination number in thousands, calculated are 0.330 and 1.650 respectively.

Tephrosia jamnagarensis Santapau

In this species, 640 epidermal cells per mm^2, of 45x22 μ average size for abaxial surface and 720 cells per mm^2, of 38x19 μ average size for adaxial surface, are recorded. The leaves showed the presence of anomocytic (13%), paracytic (52%) and anisocytic (35%) types of stomata. The stomatal index values and stomatal frequency per mm^2 values determined for the two surfaces, differ considerably from each other (Table 3:7). In contrast to this, values of guard cell size viz., 22x08 μ for the lower surface and 19x07 μ for the upper surface, show marginal difference.

In this species also, simple leaf shows basic pinnate camptodromous venation pattern which gets modified to form brochidodromous type. Among the Tephrosia species studied, T. jamnagarensis showed highest number of secondary veins on either side of the mid vein. The highest degree vein order is traced upto 4°. Areoles are small in size. On an average as many as 5 areoles per mm^2 leaf area, are seen. Veinlets are usually unbranched. The quantitative data, with respect to absolute vein islet number and absolute vein termination number in thousands, are presented in table 3:9. The nature of loop formation is more or less similar to that of the preceding species.

<u>Tephrosia</u> <u>uniflora</u> Pers. subsp. <u>petrosa</u> Blatt. & Hall

Among the species of <u>Tephrosia</u> studied the value of epidermal cell frequency per mm^2, <u>T</u>. <u>uniflora</u> i. e. 1744 for the upper surface, is the highest. The values for length x breadth determined for epidermal cell of two surfaces are quite comparable (Table 3:6). Epidermal peel study revealed the presence of 3 types of stomata distributed as 15% of anomocytic, 64% of paracytic and 21% of anisocytic. The values for stomatal frequency, index and guard cell size, recorded for the abaxial surface are comparatively higher than those recorded for adaxial surface. Stomata, in general, are uniformly distributed on both the surfaces. However, occasional indistinct grouping of stomata is observed (Pl. 3:5-L).

In this species 8 to 10, almost parallel running secondaries, upturn near the margin and join superadjacents to form brochidodromous venation (Pl. 3:14-B) of leaflet. Composite intersecondaries are commonly seen in the intercostal regions. The vein order identified is upto 5°. Irregularly oriented rectangular areoles are of 0.25 mm^2 average size. Absolute vein islet number in thousands determined for the species is 0.456. Veinlets are mostly simple having curved path (Pl. 3:15-D). 24 veinlets and 36 vein ending terminations, within areoles per mm^2 area of leaflet are observed. 4.104 is the value determined as absolute vein termination number in thousands (Table 3:9).

<u>Tephrosia</u> <u>subtriflora</u> Hochst.

Epidermal cell frequency counts per unit area, for abaxial and adaxial surfaces, show very little difference. The cell size of two surfaces also, show only, marginal difference (Table 3:6). 17%, 57% and 26% are the respective values recorded for distribution of anomocytic, paracytic and anisocytic types of stomata. Determined stomatal frequency per mm^2 for lower and upper surface is 224 & 160 respectively, while the recorded stomatal index values are 24 & 18 for the two surfaces (Table 3:7).

Each leaflet having basic pinnate camptodromous venation, is with moderately thick but distinct mid vein, which follows a straight course (Pl. 3:14-C). On either side of the primary vein, on an average 19 to 20 secondaries along with few composite intersecondaries, are noticed. Marginal ultimate venation is looped (Pl. 3:15-B). Areoles formed by all degrees of veins are either polygonal or rectangular. Areoles are comparatively bigger in size. Both simple and branched veinlets follow a curved path (Pl. 3:15-C). Other relevant quantitative data are presented in Table 3:9.

<u>Tephrosia</u> <u>villosa</u> (L.) Pers.

In this species, difference in the epidermal cell frequency per mm^2 for the two surfaces is marked (Table 3:6).

41x24 μ and 47x26 μ are the length x breadth values determined for the epidermal cells of abaxial and adaxial surfaces respectively. Among the Tephrosia species investigated, largest sized epidermal cells are recorded in this species (Table 3:6). Paracytic stomata though predominant are represented by only 52%, while the other 2 types viz., anomocytic and anisocytic are represented by 18 and 30 per cent respectively. Subsidiary cells, flanking paracytic stomata are either contiguous or non-contiguous at one or both the poles. Occasional grouping of stomata, specially on the lower surface of leaflet, is noticed (Pl.3:5-M). The average guard cell size, for the two surfaces, is more or less the same. Stomatal frequency per mm^2 224 & 160 and stomatal index 22 & 16, determined for the two surfaces, differ markedly (Table 3:7).

Modified brochidodromous venation is observed for the species. The number of secondaries on either side of the mid vein range between 11 to 13. On an average 5 areoles, of 0.20 mm^2 average size for a unit area of leaflet, are noticed. Veinlets are mostly simple and 35 vein ending terminations per mm^2 area are recorded. Other quantitative data of the venation pattern are presented in Table 3:9.

Tephrosia falciformis Ramaswamy

Epidermal cell frequency per mm^2, for the lower and upper surfaces, 1104 & 1172 are recorded respectively.

Determined cell size for lower surface is 40x20 μ and 36x18 μ for the upper surface. Among the types of stomata observed, paracytic are represented by 62%, anomocytic by 13% and anisocytic by 25%. The guard cell size is same for both the surfaces. The stomatal frequency and index 242 & 160 and 18 & 12 are determined for the lower and upper surfaces respectively (Table 3:7). Subsidiary cells of paracytic stomata are non-contiguous at one or both the poles. On few occasions contiguous stomata having juxtaposed orientation have been noticed (Fig. 3:5-N, O).

Leaflet exhibit pinnate camptodromous type of venation pattern. On an average 12 to 15 secondary veins, which run almost parallel to each other, on either side of mid vein are observed. Marginal ultimate venation formed by them is not prominently looped (Pl. 3:15-A). Areoles are mostly rectangular and occasionally polygonal in shape. The average calculated size for areole is 0.25 mm^2. Veinlets are asymmetrically more than once forked and curved. The observed number of veinlets entering areoles per mm^2 is as high as 32. The calculated veinislet number and absolute termination number in thousands are 0.400 and 11.700 respectively. Often one or a few trachieds in a group are noticed, at the vein endings. Trachieds within an areole are of uniseriate nature (Pl. 3:16-D, E, G, H).

Tephrosia wallichii Grahm.

Epidermal cell frequency per mm^2 1520 & 1264 are recorded for lower and upper surfaces respectively. 33x22 μ and 36x25 μ are the respective values for epidermal cell size of lower and upper surface. Paracytic type of stomata though predominant are represented by 50% only. Other 2 types viz., anomocytic and anisocytic show 13 and 37 per cent distribution. The data concerning stomatal frequency, index and size of guard cell for abaxial and adaxial surfaces are presented in Table 3:7 point towards the distinctness of the two surfaces. Non-contiguous nature of subsidiary cells of paracytic stomata of abaxial surface is quite evident. Presence of juxtaposed contiguous stomata is the only abnormality observed in this species(Pl. 3:6-A,B).

Like preceding species, leaflets of T. wallichii also shows pinnate camptodromous type of venation. The moderately strong midrib runs straight. 8 to 10 secondaries are observed on either side of the midrib. Near the margin these secondaries turn upward and join superadjacents to form loops (Pl. 3:1). Veins of all the degrees are involved in the formation of areoles. Areoles are usually rectangular in shape, of 0.5 mm^2 average size. Veinlets are mostly unbranched and curved. The number of veinlets entering areoles per mm^2 area is 19. Other numerical data concerning venation pattern are presented in Table 3:9.

<u>Tephrosia</u> <u>candida</u> DC.

Epidermal cell frequency per mm^2 recorded for the abaxial surface is 1168 and 1284 for the adaxial surface. The cells are comparatively smaller in size and the recorded values for the same are 25x20 μ & 24x18 μ, for the two surfaces. Epidermal peel study revealed the presence of 3 types of stomata viz., anomocytic, paracytic and anisocytic. Predominantly occurring paracytic type of stomata are represented by 45% only, which is the lowest among all the species studied (Table 3:8). The stomatal frequency per mm^2 240 & 160 and stomatal index 17 & 11 are recorded for the lower and upper surfaces of leaflet respectively. The guard cell size on the two surfaces is more or less the same (Table 3:7).

In this species the basic venation pattern is pinnate camptodromous, in which secondaries form loops near the margin. On an average 11 to 12 secondaries are noticed on either side of the mid vein. Areoles are mostly rectangular and comparatively larger in size i.e. 0.5 mm^2. Veinlets are simple and curved. Absolute vein islet number in thousands determined is 0.146. Loop formation is commonly observed in this species. Trachieds associated with the vein endings are uni, bi or multiseriate. Only in this species, isolated trachieds lying free within an areole are occasionally observed (Pl. 3:15-E,F). 0.730 is the determined number in thousands for absolute vein termination (Table 3:9).

Tephrosia purpurea (L.) Pers.

The value for the epidermal cell frequency of the two surfaces show only marginal difference. 36x19 μ and 32x22 μ are recorded length x breadth of epidermal cells for the two surfaces. An analysis of the data given in Table 3:8 concerning stomata indicates a few noteworthy features for the species. Among the species studied the predominant paracytic type is represented by the highest percentage (69%) while anomocytic type is represented by the lowest percentage (5%). The values for stomatal frequency 256 & 240, size of guard cell 16x06 μ and 18x06 μ, determined for the lower and upper surfaces are slightly different while the stomatal index value for the two surfaces is the same (Table 3:7).

The leaflet clearly shows pinnate camptodromous venation pattern (Pl. 3:14-A). Moderately strong midrib is having 10-12 secondaries on either side. Marginal arches formed by the secondaries are not prominent. 5° is the highest vein order observed. Areoles are mostly rectangular of 0.33 mm^2 average size. As many as 18 veinlets entering areoles per unit area of leaflet, are observed. Veinlets are mostly branched and curved. Vein termination number per mm^2 is 30 for the species. Other quantitative data for the venation pattern are presented in Table 3:9.

Tephrosia pumila (Lamk.) Pers.

Lesser values of epidermal cell frequency 320 and 256 for the abaxial and adaxial surfaces, are recorded. 26x22 μ and 36x16 μ are the respective measurements for length x breadth of epidermal cells on the lower and upper side of the leaflet. 15%, 60% and 25% are the respective abundancy values of anomocytic, paracytic and anisocytic stomata. Among the species of *Tephrosia* studied, this taxon has, the lowest stomatal frequency value (144) for the lower surface. In contrast to this the values for stomatal index are quite high i.e. 31 and 27. The size of the guard cells, on two surfaces, is comparable (Table 3:7).

Venation pattern is similar to that of the preceding species. However, lesser number of secondaries on either side of mid vein, large sized areole, less number of veinlets and vein terminations within an areole, minimum values of absolute vein islet and vein endings terminations in thousands are the noteworthy features (Table 3:9).

Tephrosia hamiltonii Drumm.

In this species the epidermal cell frequency for abaxial and adaxial surfaces are determined as 1472 & 1200 respectively. The cell size of the two surfaces is quite variable (Table 3:6). Anomocytic, paracytic and anisocytic types of stomata are distributed in 8%, 62% and 30% respectively. Stomatal frequencies, 360 and 304 for the two surfaces are recorded. The stomatal index values calculated for the two surfaces are the same. The guard cell size, for ~~the~~ both the surfaces, is more or less the same (Table 3:7). In this species also like many preceding species, the subsidiary cells of paracytic stoma are contiguous or non-contiguous at one or both the poles (Pl 3:6-E,F).

In this species too, resemblance in basic venation pattern to other species of Tephrosia is seen. On each side of the mid vein 9 to 11 secondaries are present. Areoles are mostly rectangular of 0.25 mm^2 average size. Both simple and branched veinlets are curved at tips. 15 veinlets and 25 vein terminations are recorded. The calculated absolute veinislet number and absolute vein termination number in thousands are 0.320 and 2.000 respectively (Table 3:9).

Psoralea corylifolia L.

The shape of epidermal cell is polygonal or quadrangular. The anticlinal walls are straight and arched. The epidermal cell size (34x16 μ and 43x23 μ) and frequency (496 & 672) are quite variable for the two surfaces. Of the 2 types of stomata viz., paracytic and anisocytic, the percentage distribution of the latter type is neglegible i.e., 3% only (Table 3:8) Pl.3:6-G,H).
Stomatal frequency 560 for the lower surface and 480 for

upper surface, are calculated. Stomatal index 53 and 41 are recorded for lower and upper surfaces respectively. 22x08 μ and 19x07 μ are the respective guard cell size values for abaxial and adaxial surfaces. The above mentioned values of stomatal frequency and index clearly indicate the differences in the two surfaces. However, the guard cell size for the two surfaces is comparable.

The venation pattern of *Psoralea corylifolia* resembles *Tephrosia* species in basic pattern. 6-8 secondaries, near the margin upturn and join superadjacents to form brochidodromous type of venation. However, the prominent intramarginal arches are not observed. Occasional occurrence of intersecondary veins on both the sides of mid vein is noticed. Variously shaped areoles of 0.5 mm^2 average size, are observed. Veinlets entering areoles are simple or branched. 24 veinlets and 32 vein endings per mm^2 area of the areoles are recorded. Absolute veinislet number and absolute vein termination number in thousands are 1.720 and 27.520 respectively (Table 3:9).

Table 3:1. Showing size in μ and frequency of epidermal cell/mm^2 in the selected taxa of Solanaceae.

Sr. No.	Name of the taxa	EPIDERMIS					
		Frequency/mm^2		Size in μ			
		Lower surface	Upper surface	Lower surface		Upper surface	
				L	B	L	B
1.	*Nicandra physalodes*	384	464	98	47	75	36
2.	*Lycium barbarum*	640	720	52	34	49	32
3.	*Withania somnifera*	464	1040	53	23	48	19
4.	*Physalis longifolia*	688	640	118	45	107	23
5.	*P. minima*	288	272	77	23	43	22
6.	*Solanum villosum* subsp. *villosum*	144	244	76	50	82	32
7.	*S. villosum* subsp. *puniceum*	208	192	117	35	120	34
8.	*S. chenopodioides*	304	320	80	27	94	27
9.	*S. scabrum*	256	224	122	39	82	49
10.	*S. americanum*	336	368	84	22	109	32
11.	*S. roxburghii*	400	640	65	25	65	17
12.	*S. purpureilineatum*	304	320	92	36	117	48
13.	*S. nodiflorum*	352	176	120	49	108	26
14.	*S. nigrum*	368	480	60	22	68	23
15.	*S. nigrum* (Red veined form)	256	192	93	35	117	38
16.	*S. viarum*	528	448	47	23	49	20
17.	*S. trilobatum*	1088	448	50	18	55	31
18.	*S. heterodoxum*	288	352	88	42	90	39

Table 3:2. Showing the distribution and abundance of Trichomes in the selected taxa of Solanaceae.

Sr. No.	Name of the species	E G L A N D U L A R					GLANDULAR CAPITATE	
		Unicellular	Simple uniseriate filiform	Conical uniseriate	Branched	Stellate	Short stalked with multi-cellular head	Long uni-seriate stalked with uni-cellular head
1.	Nicandra physalodes	–	–	C	–	–	R	C
2.	Lycium barbarum	–	R	–	–	–	–	–
3.	Withania somnifera	–	–	–	C	R	–	–
4.	Physalis longifolia	–	–	O	–	–	–	C
5.	P. minima	–	–	O	–	–	–	C
6.	Solanum villosum subsp. villosum	C	–	–	–	–	–	C
7.	S. villosum subsp. puniceum	C	–	–	–	–	–	O
8.	S. chenopodioides	C	C	–	–	–	–	–
9.	S. scabrum	–	–	–	–	R	–	C
10.	S. americanum	–	–	–	–	R	–	C
11.	S. roxburghii	–	C	–	–	–	–	–
12.	S. purpureilineatum	–	C	–	–	–	–	–
13.	S. nodiflorum	–	–	C	–	–	–	–
14.	S. nigrum	–	–	–	–	R	–	C
15.	S. nigrum (Red veined form)	–	–	–	–	R	O	C
16.	S. viarum	C	R	–	–	–	–	C
17.	S. trilobatum	–	–	–	–	C	–	–
18.	S. heterodoxum	–	–	–	–	–	–	C

C = Common R = Rare O = Occasional

Table 3:3. Showing the frequency of stomata and stomatal index per mm^2 and size of guard cell in the selected taxa of Solanaceae.

Sr. No.	Name of the taxa	STOMATA: Frequency per mm^2		SI per mm^2		Size in μ			
		Lower surface	Upper surface	Lower surface	Upper surface	Lower surface L	Lower surface B	Upper surface L	Upper surface B
1.	Nicandra physalodes	128	96	25	17	31	09	32	10
2.	Lycium barbarum	96	96	11	10	23	07	32	10
3.	Withania somnifera	96	80	17	07	34	13	23	09
4.	Physalis longifolia	112	80	14	11	28	10	31	09
5.	P. minima	160	32	35	10	23	09	19	07
6.	Solanum villosum subsp. villosum	96	33	40	25	26	10	25	09
7.	S. villosum subsp. puniceum	80	48	28	20	28	11	25	10
8.	S. chenopodioides	112	80	26	20	33	09	26	09
9.	S. scabrum	112	48	30	18	24	09	26	09
10.	S. americanum	160	48	32	11	25	08	23	08
11.	S. roxburghii	176	48	30	06	31	10	27	09
12.	S. purpureilineatum	82	48	20	13	36	10	30	09
13.	S. nodiflorum	128	32	26	15	33	11	34	09
14.	S. nigrum	192	112	34	19	24	07	17	06
15.	S. nigrum (Red veined form)	80	32	23	13	24	09	24	08
16.	S. viarum	320	80	37	15	24	08	24	09
17.	S. trilobatum	112	48	10	06	27	10	25	09
18.	S. heterodoxum	128	112	30	24	26	10	23	09

Table 3:4. Showing the percentage frequency of 'types' of stomata in the selected taxa of Solanaceae.

Sr. No.	Name of taxa	Anomocytic	Paracytic	Hemidiacytic	Anisocytic	Stoma with a single subsidiary cell.
1.	*Nicandra physalodes*	31	24		35	10
2.	*Lycium barbarum*	58	17		25	
3.	*Withania somnifera*	25	37		28	10
4.	*Physalis longifolia*	68		1	31	
5.	*P. minima*	31	17		44	8
6.	*Solanum villosum* subsp. *villosum*	12	15		73	
7.	*S. villosum* subsp. *puniceum*	29	6		55	
8.	*S. chenopodioides*	35	5		55	5
9.	*S. scabrum*	18	15		57	10
10.	*S. americanum*	25			75	
11.	*S. roxburghii*	22	11		57	10
12.	*S. nodiflorum*	17	14		65	4
13.	*S. purpureilineatum*	20	12		58	10
14.	*S. nigrum*	21	27		46	6
15.	*S. nigrum* (Red veined form)	20			76	4
16.	*S. viarum*	16	14		67	3
17.	*S. trilobatum*	25	12		63	
18.	*S. heterodoxum*	29	10		55	6

Table 3:5. Numerical data on the venation pattern of the leaves of selected taxa of Solanaceae.

Sr. No.	Name of the taxa	Leaf area in mm^2	No. of secondary veins on one side	Angle between 1°and 2° veins	Vein-islet (Areoles) per mm^2	Vein-lets entering in areoles per mm^2	Veinlet termination number	Average size of areole in mm^2	Absolute vein-islet no. in thousands	Absolute veinlet termination no. in thousand	Highest degree of vein order
1.	Nicandra physalodes	1340	4 - 5	45-72°	1	15	30	1.0	1.340	40.200	5°
2.	Lycium barbarum	65	5 - 7	32-85°	1	10	20	1.0	1.065	1.300	5°
3.	Withania somnifera	1232	6 - 8	60-78°	3	30	45	0.33	3.696	55.440	5°
4.	Physalis longifolia	997	6 - 7	50-95°	2	18	50	0.5	0.997	49.850	6°
5.	_. minima	378	6 - 7	45-70°	1	6	8	1.0	0.37	3.024	5°
6.	Solanum villosum	321	4 - 6	40-55°	1	15	22	1.0	0.320	7.062	5°
7.	S. villosum subsp. puniceum	450	6 - 7	42-65°	2	26	30	0.5	0.900	13.500	5°
8.	S. otonis	460	6 - 8	25-65°	2	22	20	0.5	0.920	9.200	6°
9.	S. scabrum	2225	5 - 6	60-85°	2	24	24	0.5	4.450	53.400	5°
10.	S. nigrum var. americanum	1230	7 - 8	45-70°	1	10	26	1.0	1.230	31.980	6°
11.	S. roxburghii	715	6 - 7	47-87°	2	30	44	0.5	1.430	31.460	5°
12.	S. purpurellineatum	3025	6 - 8	52-80°	1	17	40	1.0	3.025	121.000	6°
13.	S. nodiflorum	1510	6 - 7	45-95°	2	22	56	0.5	3.020	84.560	6°
14.	S. nigrum	895	6 - 8	35-90°	2	16	26	0.5	1.790	23.270	5°
15.	S. nigrum (Red veined form)	680	6 - 7	40-72°	1	8	14	1.0	0.680	9.520	5°
16.	S. viarum	650	5 - 6	45-65°	2	22	28	0.5	1.300	15.800	5°
17.	S. trilobatum	1175	5 - 6	50-60°	1	8	13	1.0	1.175	15.275	6°
18.	S. heterodoxum	478	5 - 6	45-52°	3	27	42	0.33	1.434	20.076	5°

Table 3:6. Showing frequency per mm^2 and size in μ of epidermal cell/mm^2 in the members of Fabaceae.

Sr. No.	Name of the taxa	EPIDERMIS					
		Frequency/mm^2		Size in μ			
		Lower surface	Upper surface	Lower surface L	Lower surface B	Upper surface L	Upper surface B
1.	Tephrosia strigosa	672	1008	39	26	43	20
2.	T. jamnagarensis	640	720	45	22	38	19
3.	T. uniflora subsp. petrosa	1008	1744	43	20	42	22
4.	T. subtriflora	704	720	34	25	38	24
5.	T. villosa	768	832	41	24	47	26
6.	T. falciformis	1104	1172	40	20	36	18
7.	T. wallichii	1520	1264	33	22	36	25
8.	T. candida	1168	1280	25	20	24	18
9.	T. purpurea	1360	1392	36	19	32	22
10.	T. pumila	320	256	22	22	30	16
11.	T. hamiltonii	1472	1200	26	22	30	16
12.	Psoralea corylifolia	496	672	34	16	43	23

Table 3:7. Showing the frequency of stomata, stomatal index and size of the guard cell in u in the members of Fabaceae.

Sr. No.	Name of the taxa	STOMATA							
		Frequency per mm^2		SI per mm^2		Size in μ			
		Lower surface	Upper surface	Lower surface	Upper surface	Lower surface L	Lower surface B	Upper surface L	Upper surface B
1.	_Tephrosia strigosa_	320	192	32	24	20	08	18	06
2.	_T. jamnagarensis_	240	160	28	19	22	08	19	07
3.	_T. uniflora_ subsp. _petrosa_	208	48	17	03	22	06	16	06
4.	_T. subtriflora_	224	160	24	18	20	08	20	07
5.	_T. villosa_	224	160	22	16	18	07	20	07
6.	_T. falciformis_	242	160	18	12	22	08	22	08
7.	_T. wallichii_	304	192	16	13	16	06	20	07
8.	_T. candida_	240	160	17	11	18	08	17	07
9.	_T. purpurea_	256	240	15	15	16	06	18	06
10.	_T. pumila_	144	96	31	27	16	06	17	06
11.	_T. hamiltonii_	360	304	20	20	16	06	17	06
12.	_Psoralea corylifolia_	560	480	53	41	22	08	19	07

Table 3:8. Showing percentage frequency of the 'types' of stomata in the members of Fabaceae.

Sr. No.	Name of the taxa	Anomocytic	Paracytic	Anisocytic
1.	*Tephrosia strigosa*	15	60	25
2.	*T. jamnagarensis*	13	52	35
3.	*T. uniflora* subsp. *petrosa*	15	64	21
4.	*T. subtriflora*	17	57	26
5.	*T. villosa*	18	52	30
6.	*T. falciformis*	13	62	25
7.	*T. wallichii*	13	50	37
8.	*T. candida*	31	45	24
9.	*T. purpurea*	5	69	26
10.	*T. pumila*	15	60	25
11.	*T. hamiltonii*	8	62	30
12.	*Psoralea corylifolia*	-	97	3

Table 3:9. Numerical data on the venation pattern of the leaves and leaflets of members of Fabaceae.

Sr. No.	Name of the taxa	Leaf area in mm^2	No. of secondary veins on one side	Angle between 1° and 2° veins	Vein-islet (areoles) per mm^2	Vein-lets entering in areoles per mm^2	Veinlet termination number	Average size of areoles in mm^2	Absolute vein-islet no. in thousands	Absolute veinlet termination no. in thousand	Highest degree of vein order
1.	Tephrosia strigosa	66	18 - 20	20-32°	5	30	25	0.20	0.330	1.650	4°
2.	T. jamnagarensis	133	24 - 30	20-43°	5	35	30	0.20	0.665	3.990	4°
3.	T. uniflora subsp. petrosa	114	8 - 10	20-35°	4	24	36	0.25	0.456	4.104	5°
4.	T. subtriflora	276	19 - 20	27-45°	2	22	26	0.5	0.552	7.176	4°
5.	T. villosa	82	11 - 13	22-35°	5	30	35	0.20	0.410	2.870	5°
6.	T. falciformis	100	12 - 15	20-40°	4	32	117	0.25	0.400	11.700	5°
7.	T. wallichii	75	8 - 10	25-31°	2	19	16	0.5	0.150	1.200	4°
8.	T. candida	73	11 - 12	22-33°	2	14	10	0.5	0.146	0.730	4°
9.	T. purpurea	95	10 - 12	27-48°	3	18	30	0.33	0.285	2.850	5°
10.	T. pumila	20	6 - 7	22-48°	2	8	10	0.5	0.040	0.200	4°
11.	T. hamiltonii	80	9 - 11	20-45°	4	15	25	0.25	0.320	2.000	5°
12.	Psoralea corylifolia	860	7 - 8	40-57°	2	24	32	0.5	1.720	27.520	5°

Pl. 3:1

Photograph of cleared leaflet of

Tephrosia wallichii

showing venation pattern.

Magnification X14

PL.3:1

Fig. 3:2 TRICHOMES

Representative types :-

Eglandular

A - Unicellular hair - *Solanum viarum*

B - " " - *Tephrosia purpurea*

C - Multicellular stellate hair - *Solanum trilobatum*

D - Uniseriate conical hair - *Nicandra physalodes*

E - Simple uniseriate filiform hair - *Solanum roxburghii*

F - " " " " - *S. viarum*

G - " " " " - *S. americanum*

H - " " conical " - *S. nigrum*
(Note wavy e cuticle) (Red veined form)

I - Branched stellate hair - *Withania somnifera*

Glandular

J - Long uniseriate stalked trichome with unicelled head - *Solanum viarum*

K - " " " " - *S. viarum*
(Note long basal cell)

L - Short stalked trichome with multicelled head - *S. nigrum*
(Red veined form)

M - " " " " - *Nicandra physalodes*

Magnifications : A - L (X265),
M (X310).

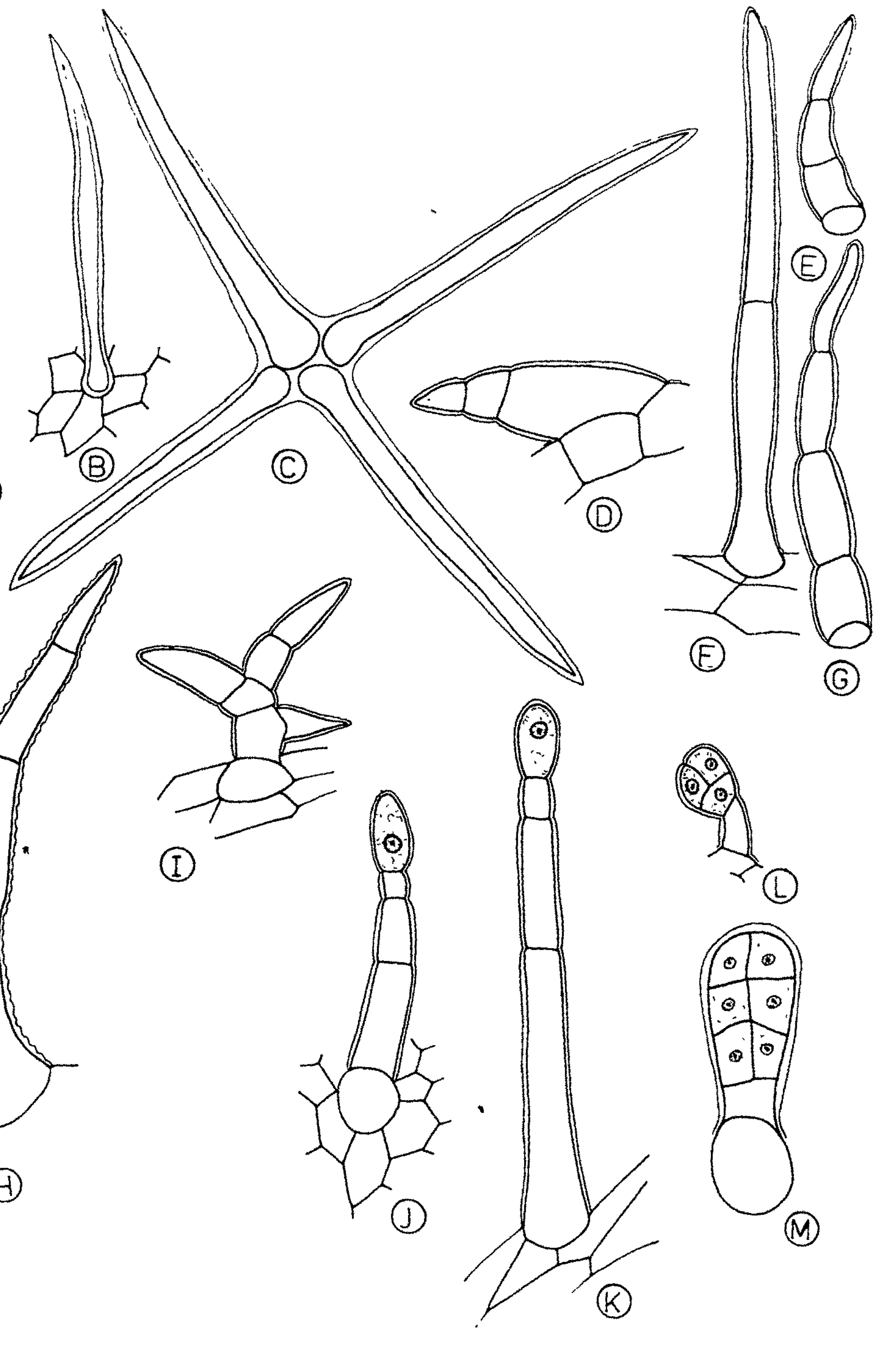

Fig. 3:2

Fig. 3:3

Epidermal peel showing :

Nicandra physalodes

A - (L.S.) - Sinuous anticlinal walls, Anom., SSC, dgc and contiguous types of stomata.

B - (U.S.) - Stomata with single guard cell (sgc).

Lycium barbarum

C - (L.S.) - Straight and arched anticlinal walls. Aniso and SSC types of stomata.

D - (U.S.) - CCS, arrested development of stomata, non contiguous para.type, normal Para and Aniso. types of stomata.

Physalis longifolia

E - (L.S.) - Loose sinuousites of anticlinal walls. para and giant sized Anom. types of stomata.

F - (U.S.) - Hemidiacytic and dgc. types of stomata.

P. minima

G - (L.S.) - Notched guard cells, PSC, dgc and SSC types of stomatal abnormalities.

H - (U.S.) - Aniso. SGC. stomatal types.

Solanum villosum subsp. villosum

I - (L.S.) - Sinuous anticlinal walls, SSC and DGC types of stomata.

J - (U.S.) - SSC, sgc and dgc types of stomata.

S. villosum subsp. puniceum

K - (L.S.) - Loose sinuousites of anticlinal walls, giant sized anom. and agc. types of stomata.

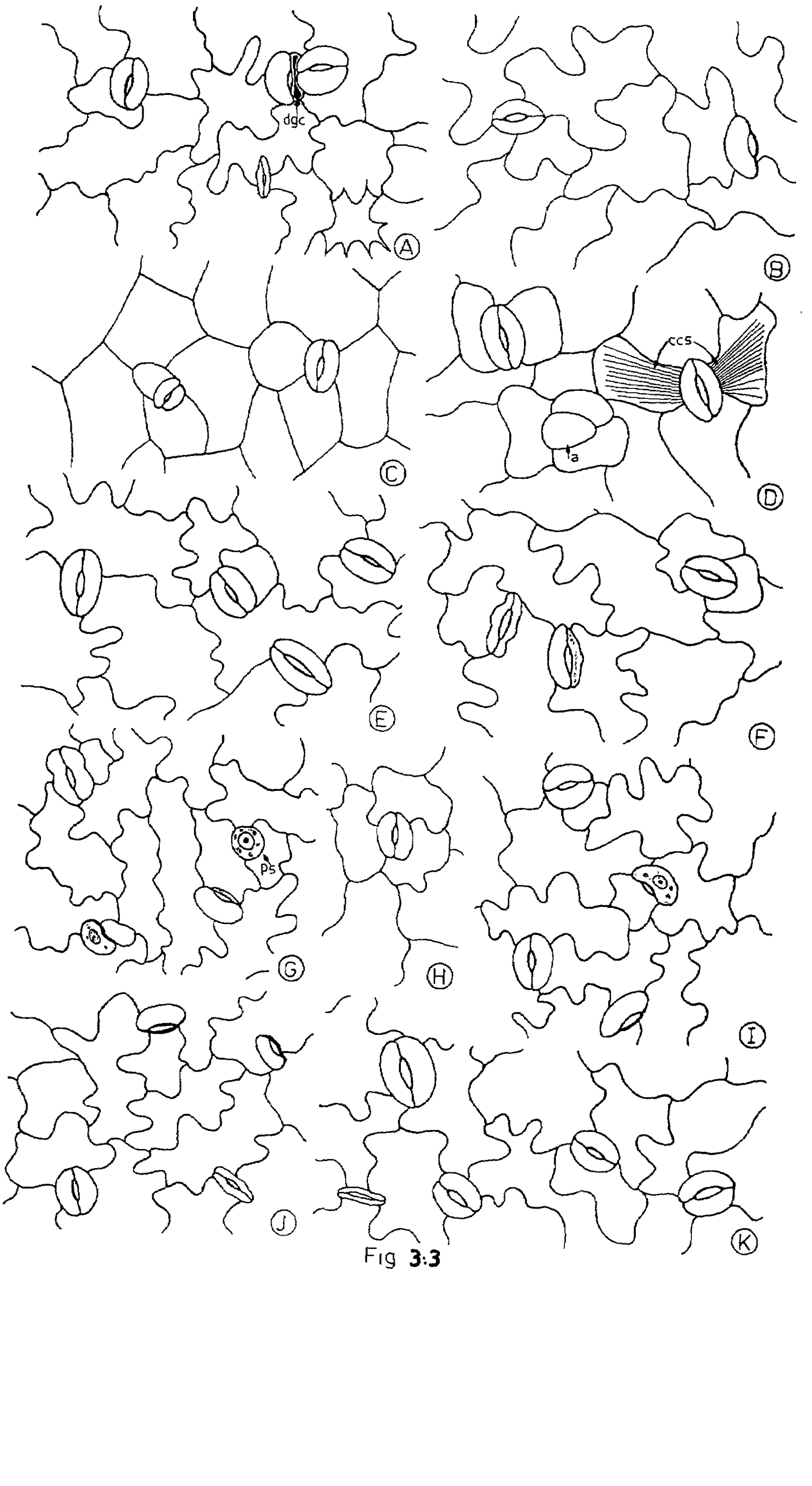

Fig 3:3

Fig. 3:4.

Epidermal peel showing :

Solanum chenopodioides

A - (U.S.) - Sinuous anticlinal walls, paracytic contiguous at both poles and ssc and types of stomata.

S. scabrum

B - (L.S.) - Loose sinuousites of anticlinal walls, aniso., psc. and dgc. types of stomata.

C - (U.S.) - One and half, contiguous stomata.

S. americanum

D - (L.S.) - Regular sinuousites of anticlinal walls, aniso., anom. and sgc. types of stomata.

E - (U.S.) - Para., aniso., ssc. and sgc. types of stomata.

S. roxburghii

F - (L.S.) - Irregular sinuousites of anticlinal walls, giant sized, para. and aniso. types of stomata.

G - (U.S.) - Non contiguous paracytic, normal para. and aniso. types of stomata.

S. purpureilineatum

H - (L.S.) - Loose sinuousites of anticlinal walls, para. and aniso. stomatal types.

I - (U.S.) - Para. and stomata with degenerating guard cell.

S. nodiflorum

J - (L.S.) - Narrow sinuousites of anticlinal walls, ccs., para., aniso., ssc. and dgc. types of stomata.

K - (U.S.) - Broad sinuousites of anticlinal walls, para., aniso. and ssc. types of stomata.

Magnifications : A - K X390

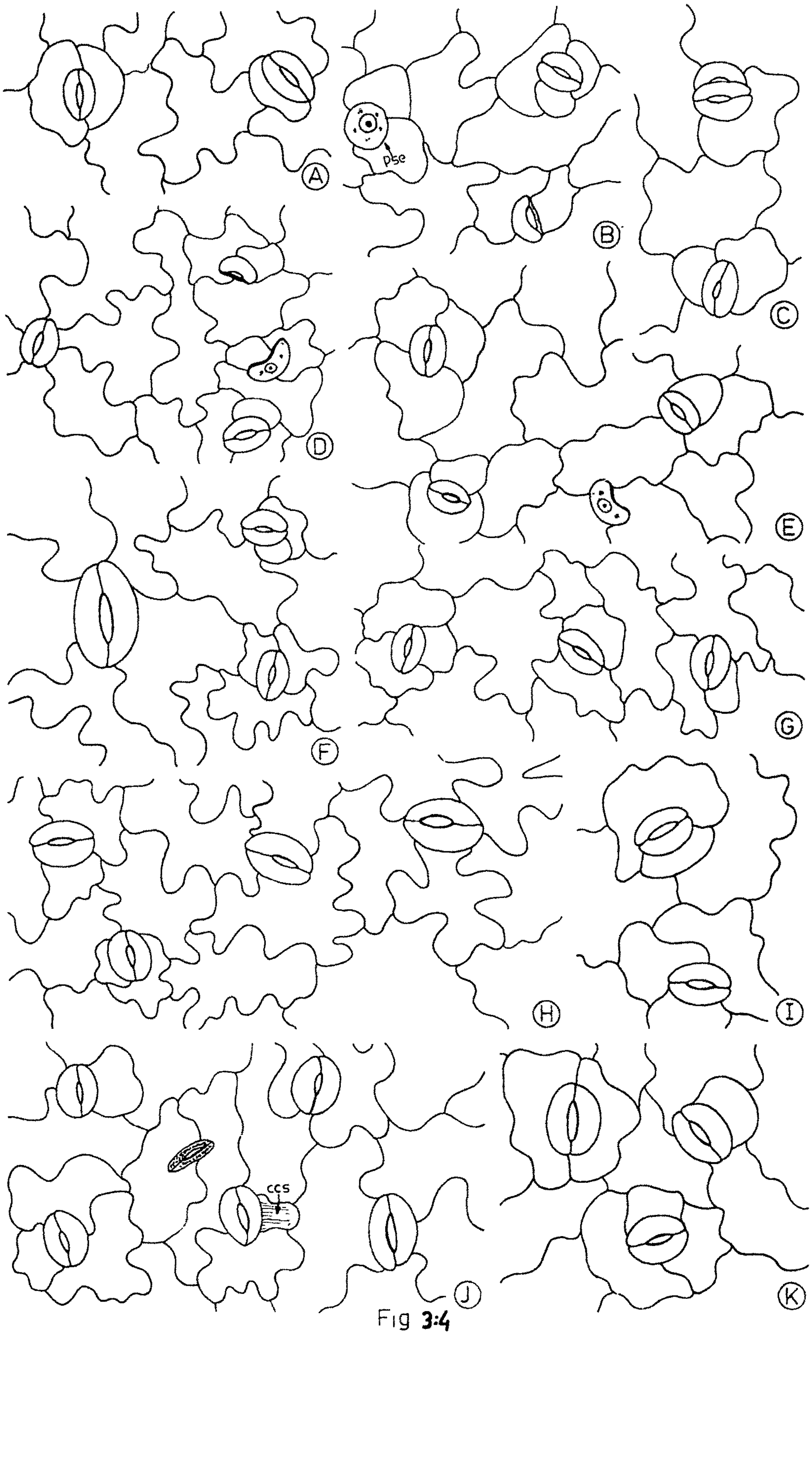

Fig 3:4

Fig. 3:5

Epidermal peel showing :

Solanum nigrum

A - (L.S.) - Irregular but prominent sinuousites of anticlinal walls, contiguous paracytic and aniso-types of stomata.

S. viarum

B - (L.S.) - Prominent sinuousites of anticlinal walls, para. and aniso-types of stomata showing grouping.

C - (U.S.) - Stomata with single guard cell.

S. trilobatum

D - (L.S.) - Ill defined sinuousites of anticlinal walls, contiguous paracytic and cytoplasmic connections (cc.) between stomata.

E - (U.S.) - Stomata with single subsidiary cell.

S. heterodoxum

F - (L.S.) - Almost straight and arched anticlinal walls of epidermal cells.

G - (U.S.) - Stomata with cuticular thickenings in form of small pads at polar ends and dgc.

Withania somnifera

H - (L.S.) - Stomata with single guard cell & degenerating guard cell.

I - (U.S.) - Para. and aniso. types of stomata.

Tephrosia strigosa

J - (L.S.) - Straight & arched anticlinal walls, contiguous & non-contiguous paracytic, anom. and aniso. types of stomata.

K - (U.S.) - " " " "

T. uniflora subsp. petrosa

L - (L.S.) - Straight & arched anticlinal walls, para. and aniso. types of stomata.

T. villosa

M - (L.S.) - Straight & arched anticlinal walls, para. and anom. types of stomata showing close orientation.

T. falciformis

N - (L.S.) - Straight & arched anticlinal walls and contiguous paracytic type of stomata.

O - (U.S.) - Juxtaposed orientation of stomata.

Magnifications : A - O X390.

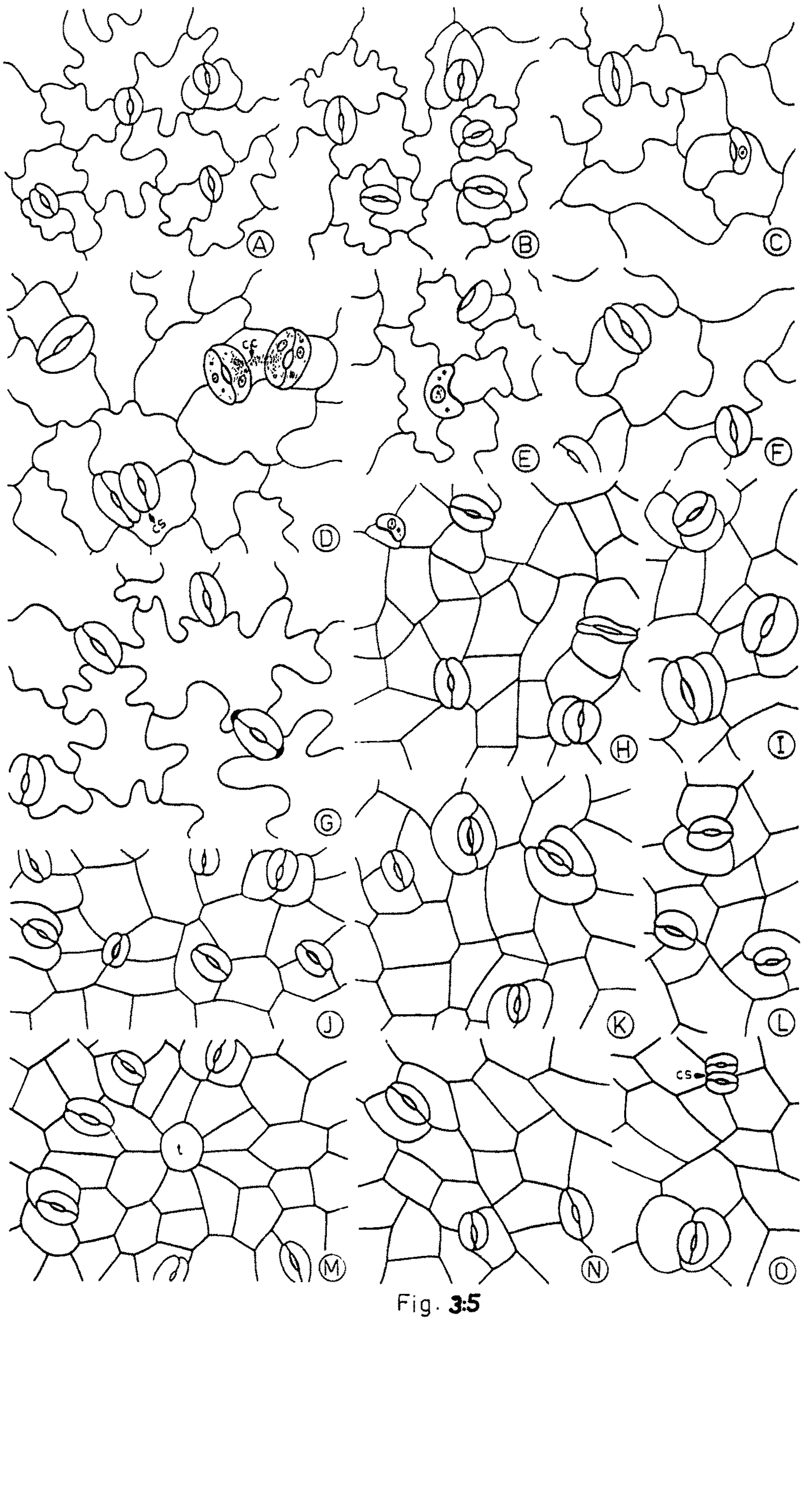

Fig. 3.5

Fig. 3:6

Epidermal peels showing :

Tephrosia wallichii

A - (L.S.) - Straight & arched anticlinal walls, para., anom. and aniso. types of stomata.

B - (U.S.) - Para., anom., aniso. and twin types of stomata.

T. purpurea

C - (L.S.) - Straight & arched anticlinal walls, para., anom. and aniso. types of stomata and one & half contiguous stomata.

D - (U.S.) - Paracytic type of stomata contiguous at one pole.

T. hamiltonii

E -(L.S.) - Straight & arched anticlinal walls, para., aniso. and anom. types of stomata.

F - (U.S.) - Close orientation of contiguous and non-contiguous para. and aniso. types of stomata.

Psoralea corylifolia

G - (L.S.) - Straight & arched anticlinal walls, close orientation of stomata, paracytic type of stomata contiguous or non-contiguous at one or both poles.

H - (U.S.) - Para. type of stomata contiguous at both ples.

Magnifications

A - H X390

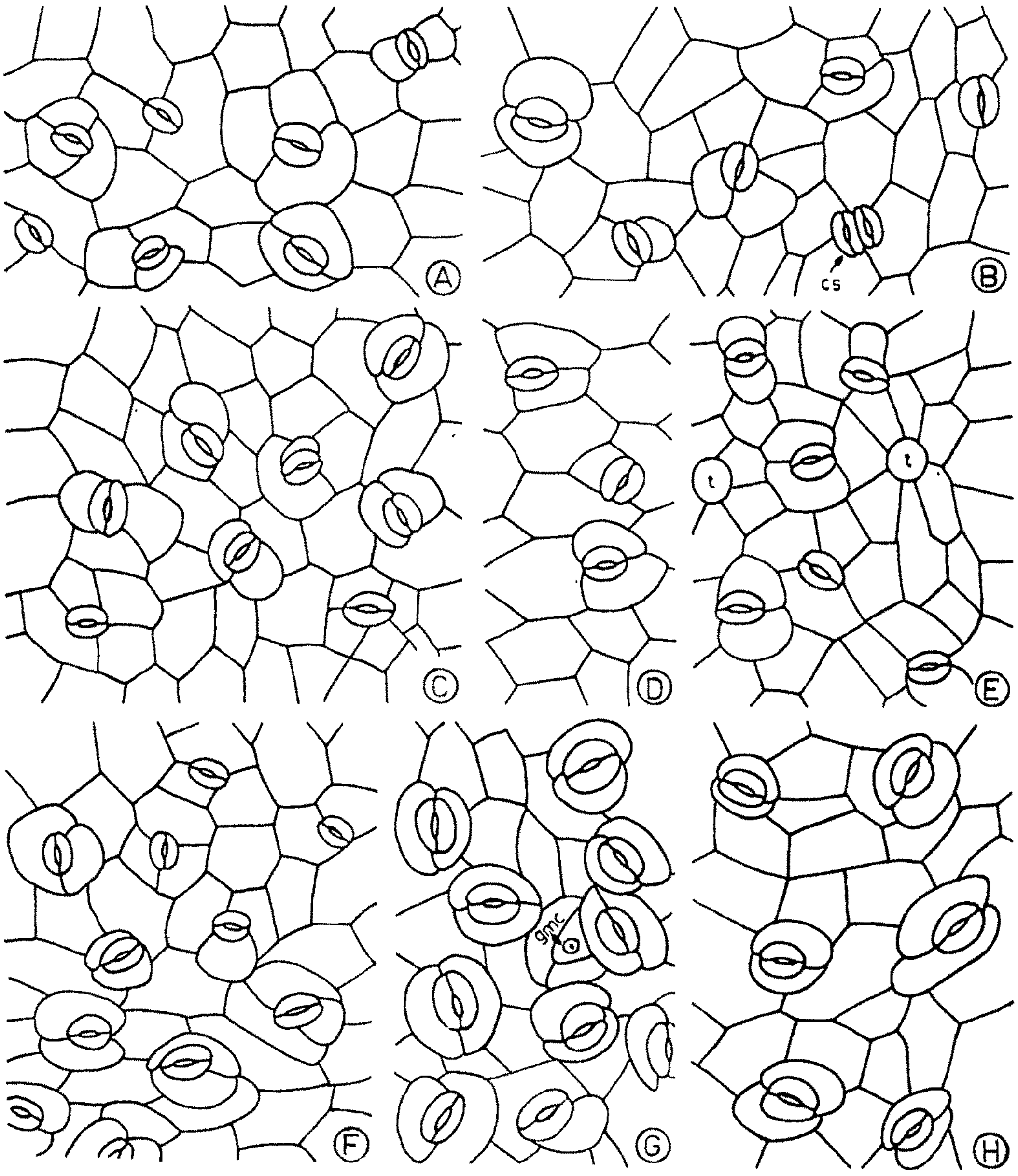

Fig. **3:6**

Plate 3:7

Photomicrographs of stomatal abnormalities.

Physalis minima

A - Persistent stomatal cell (Psc).

Solanum nigrum (Red veined form)

B - Persistent stomatal cell (Psc).

C - Binucleate persistent stomatal cell

D - Single guard cell.

Physalis minima

E - Amitotic division of guard mother cell nucleus.

F - Single guard cell.

G - " " "

Solanum trilobatum

H - Contiguous stomata.

I - Contiguous stomata.

Magnifications

A - D	X2057
E, F	X2114
G	X2571
H, I	X1485

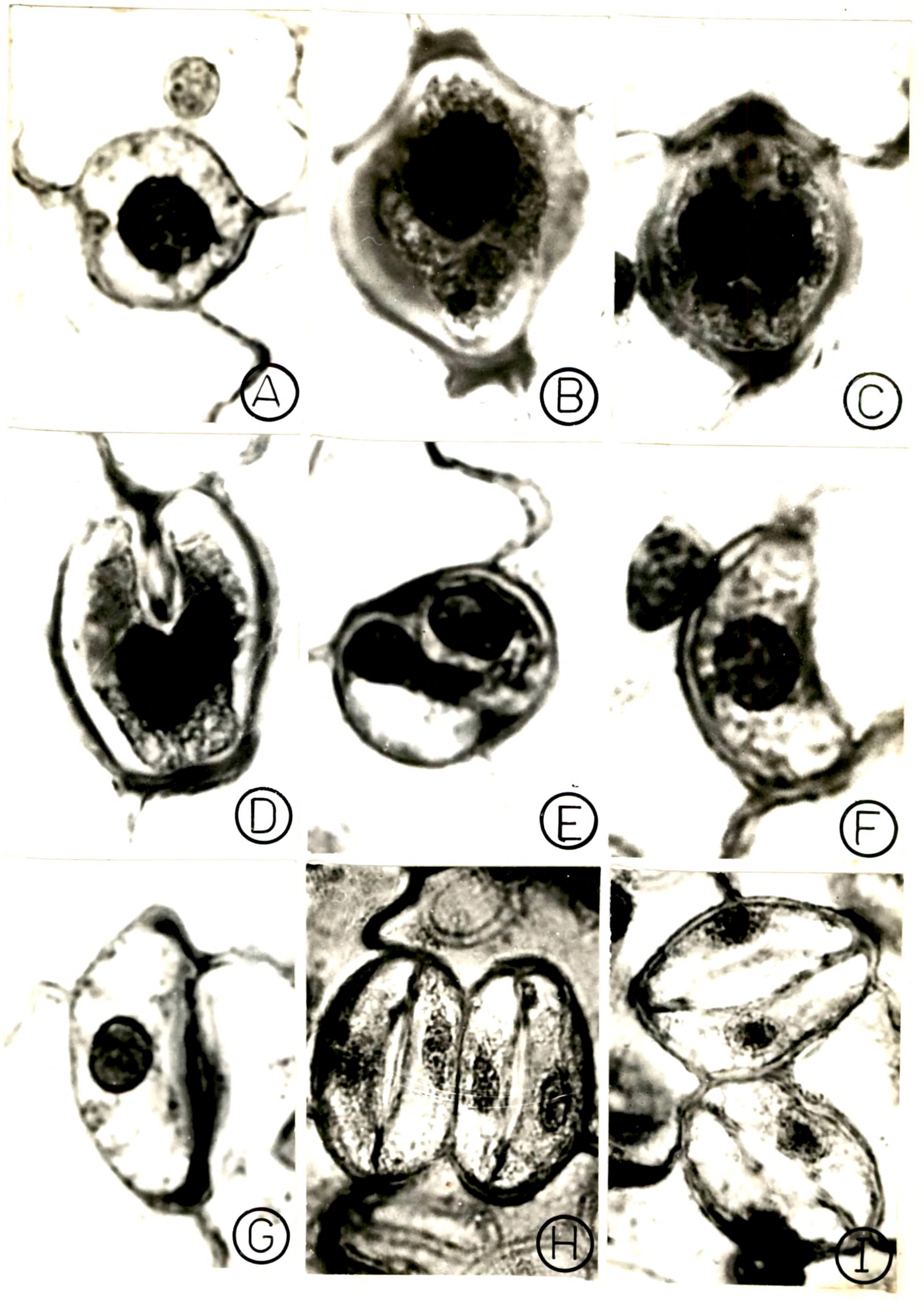

PLATE 3:7

Plate 3:8

Photographs of cleared leaves depicting venation pattern.

Solanum nodiflorum

A - Festooned brochidodromous type showing subopposite secondaries.

S. scabrum

B - Festooned brochidodromous type showing alternate secondaries and interspersed intersecondaries.

S. nigrum

C - Festooned brochidodromous type showing alternate secondaries, interspersed intersecondaries and fimbriate marginal vein.

S. nigrum (Red veined form)

D - Festooned brochidodromous type showing alternate secondaries, interspersed intersecondaries and fimbriate marginal vein.

Magnifications

A, D	X2
B	X1.5
C	X3

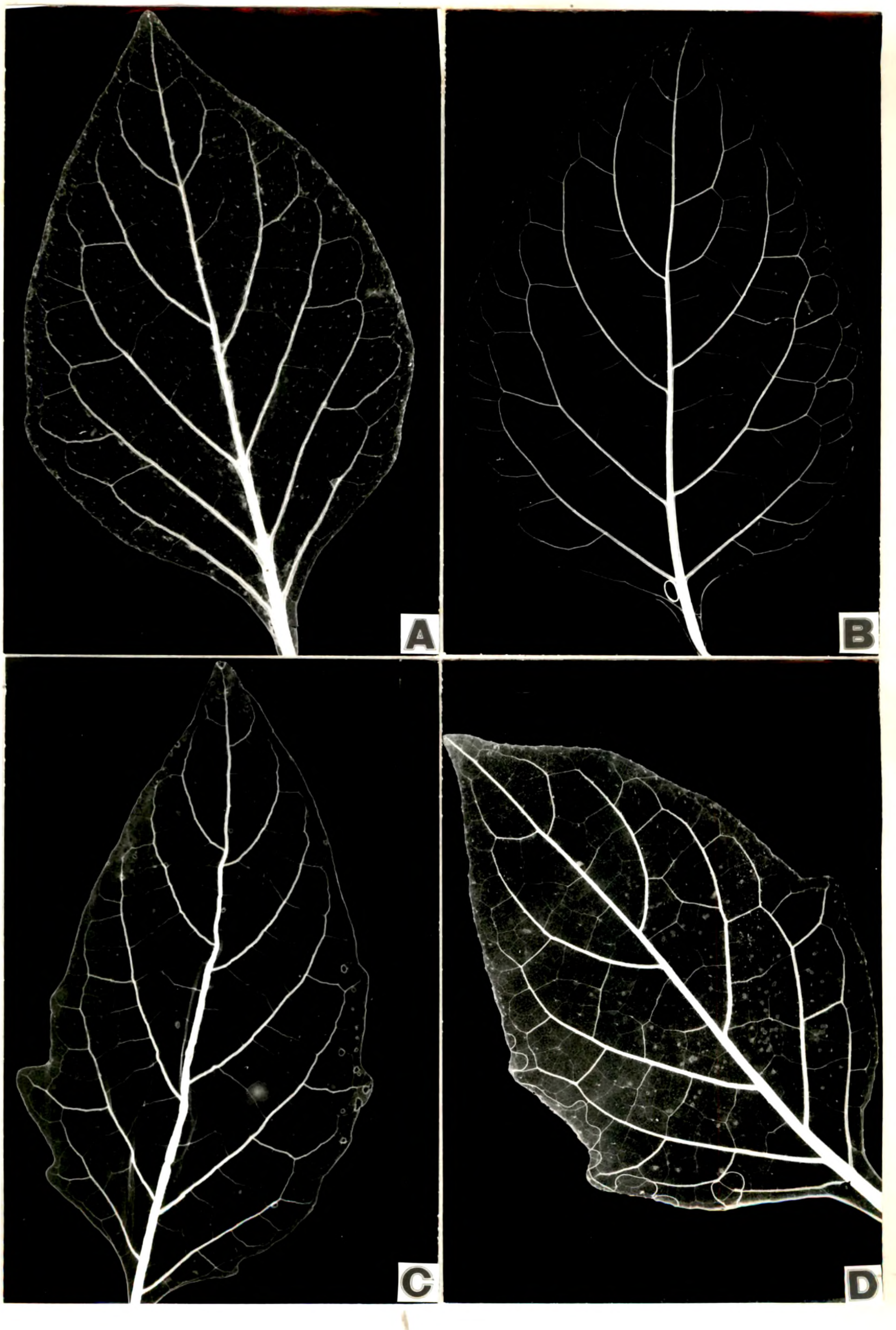

PLATE 3:8

Plate 3:9

Photographs of cleared leaves depicting venation pattern.

Physalis longifolia

A - Festooned brochidodromous type, with intersecondaries.

Solanum roxburghii

B - Festooned brochidodromous type, showing sub-opposite secondaries.

Nicandra physalodes

C - Festooned brochidodromous type, showing interspersed intersecondaries.

Solanum heterodoxum

D - Deeply dissected leaf, pinnate camptodromous type of venation pattern and sinuous secondaries.

Magnifications

A	X2
B	X3.3
C	X1.6
D	X1.5

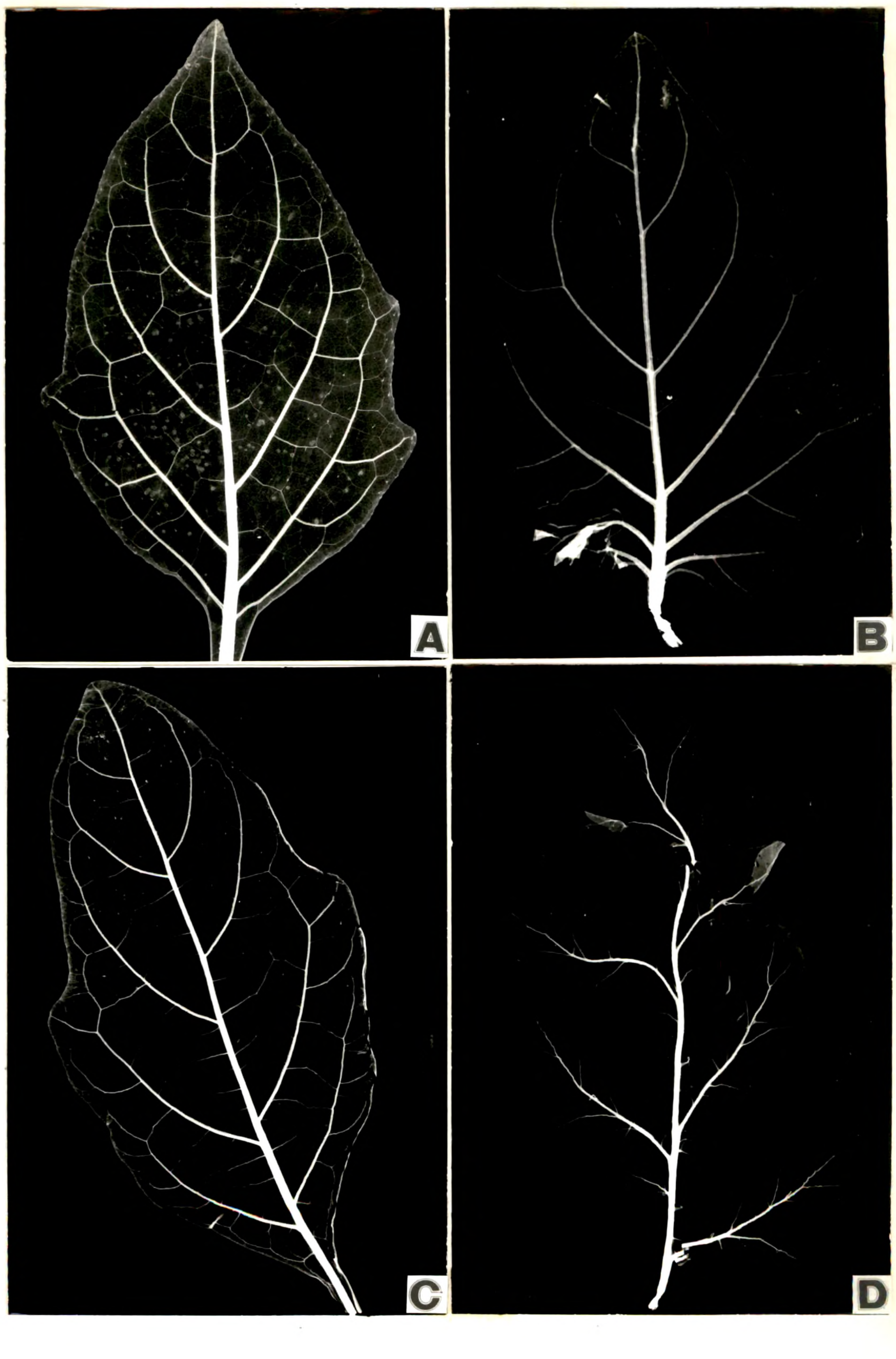

PLATE 3:9

Plate 3:10

Photomicrographs showing details of venation pattern.

Physalis longifolia

A - Leaf apex and parenchymatous bundle sheath.

P. minima

B - Leaf apex, parenchymatous bundle sheath and secondaries joining superadjacents.

Solanum purpureilineatum

C - Leaf apex and parenchymatous bundle sheath.

S. scabrum

D - Leaf apex, distinct parenchymatous bundle sheath and secondaries joining superadjacents.

S. trilobatum

E - Stellate hairs and sinuous course of veins.

S. heterodoxum

F - Marginal ultimate venation, having sinuous course of 2° and 3° veins.

Magnifications

A - F X50

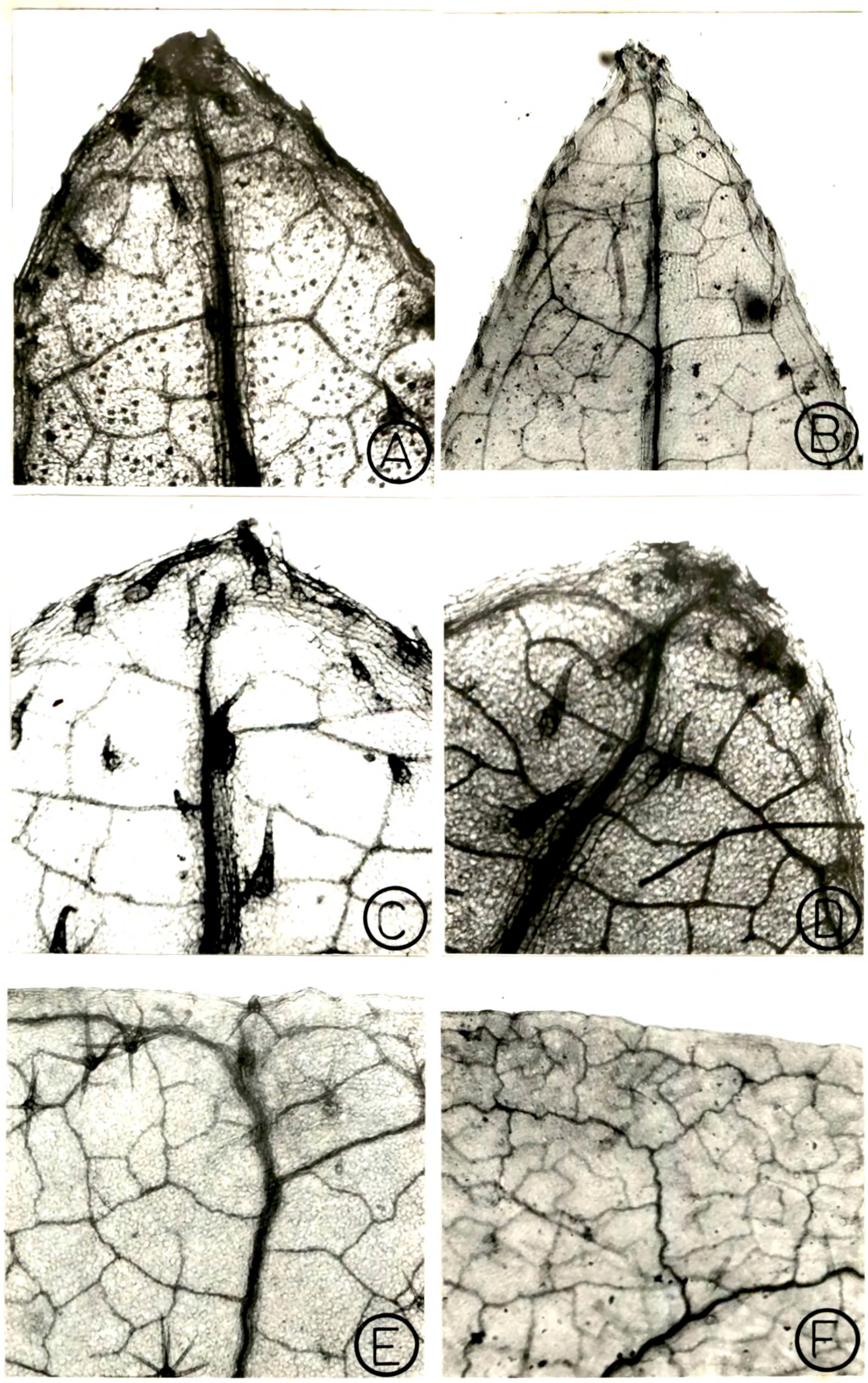

PLATE 3:10

Plate 3:11

Photomicrographs of cleared leaves showing details of venation pattern.

Solanum roxburghii

A - Englandular uniseriate trichomes and areoles.

Nicandra physalodes

B - Areole with forked veinlets having curved course.

Solanum nigrum (Red veined form)

C - Uniseriate trichomes, once or twice forked veinlets and loop formation.

Physalis longifolia

D - Simple or branched veinlets within areole.

Nicandra physalodes

E - Polygonal areole and once or twice branched veinlets.

Solanum roxburghii

F - Polygonal areole and branched veinlets.

Magnifications

A, B, C, E, F X50

D X48

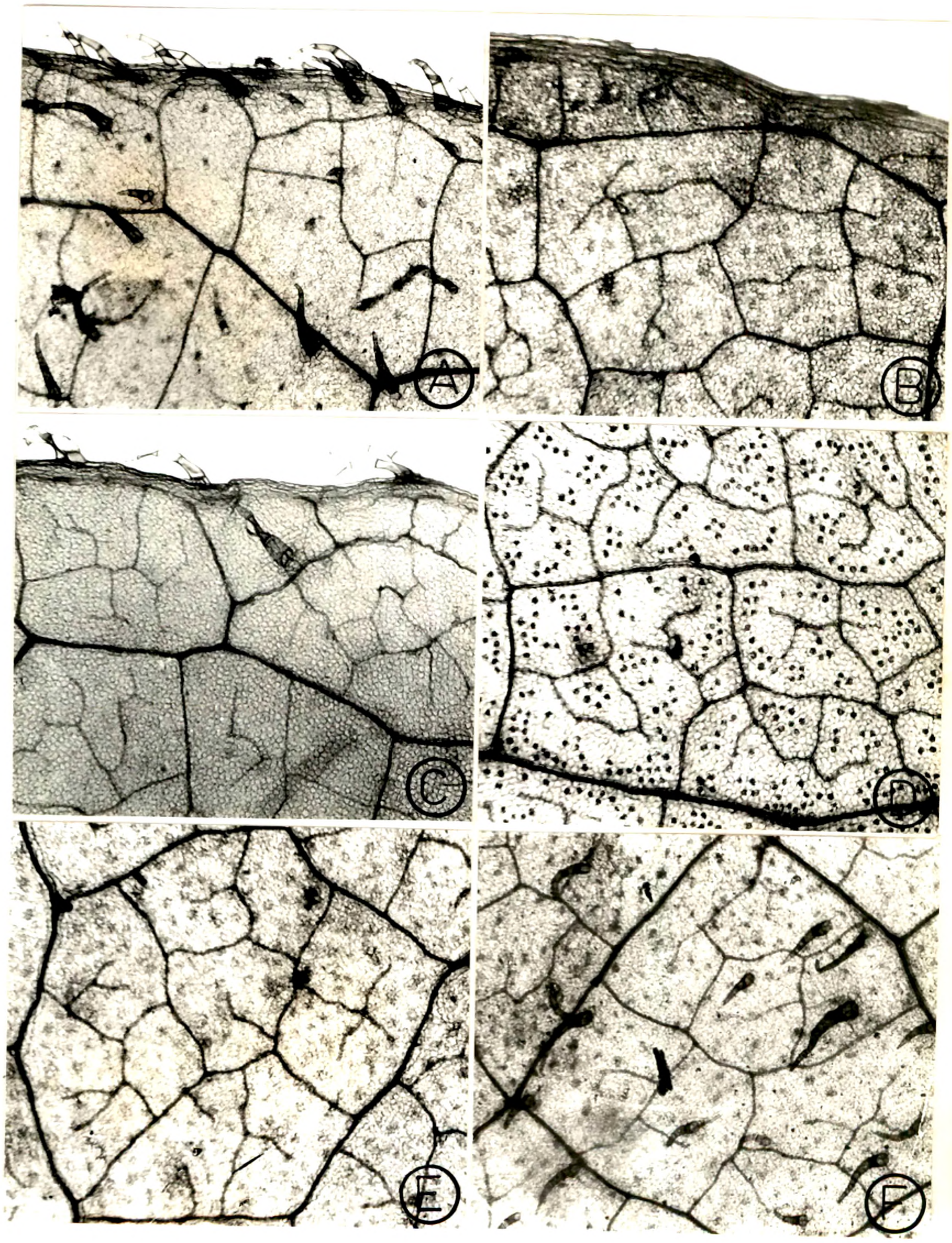

PLATE 3:11

Plate 3:12

Photomicrographs of cleared leaves showing details of venation pattern.

<u>Solanum scabrum</u>

A - Rectangular areole with simple veinlets.

B - Part of areole forming orthogonal configurations with branched veinlets.

<u>S. trilobatum</u>

C - Stellate trichomes, simple and forked veinlets.

<u>S. heterodoxum</u>

D - Sinuous course of secondary vein.

<u>S. purpureilineatum</u>

E - More than once branched vein ending and parenchymatous bundle sheath.

<u>Withania somnifera</u>

F - Loop formation.

Magnifications

A-D X 52
E X131
F X143

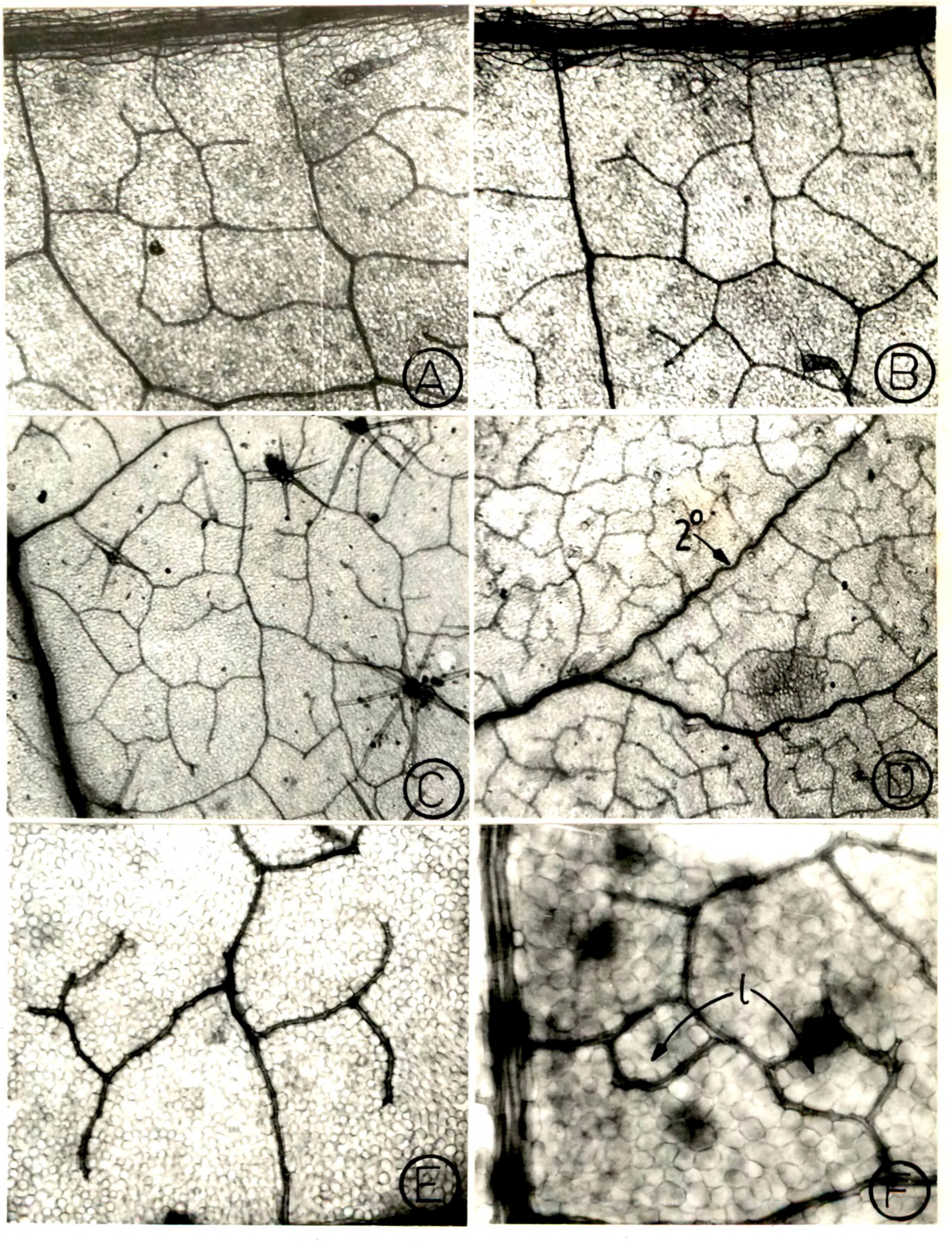

PLATE 3:12

Plate 3:13

Photomicrographs of leaves showing details of venation pattern.

Solanum purpureilineatum

A - Free vein ending.

B - Isolated vein (iv) lying free within anareole.

C - Isolated vein (iv) lying free within anareole.

S. chenopodioides

D - Extension cell (ec.)

Physalis minima

E - Branched vein ending.

Solanum chenopodioides

F - Uniseriate trachied.

Physalis minima

G - Biseriate trachied.

Magnifications

A, C	X330
B	X120
D	X300
E	X260
F	X708
G	X460

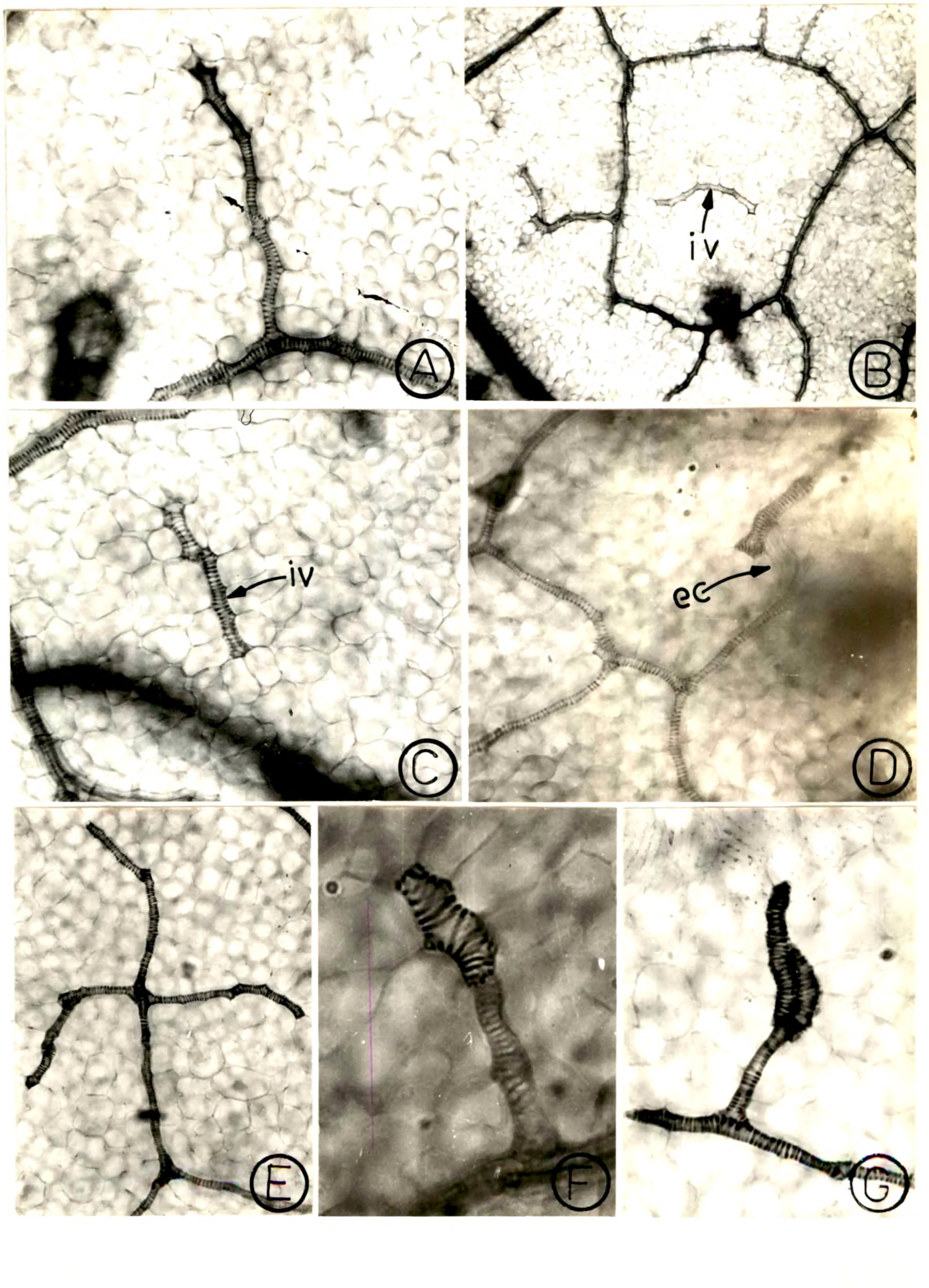

PLATE 3:13

Plate 3:14

Photographs of cleared leaflets depicting venation pattern.

Tephrosia purpurea

A - Pinnate camptodromous type with moderately strong midrib.

T. uniflora subsp. *petrosa*

B - Pinnate camptodromous type with chained and moderately strong midrib.

T. subtriflora

C - Pinnate camptodromous type with thin but straight coursed midrib.

T. pumila

D - Pinnate camptodromous type with moderately thick and straight coursed midrib.

Magnifications

A, B X6
C X3
D X9

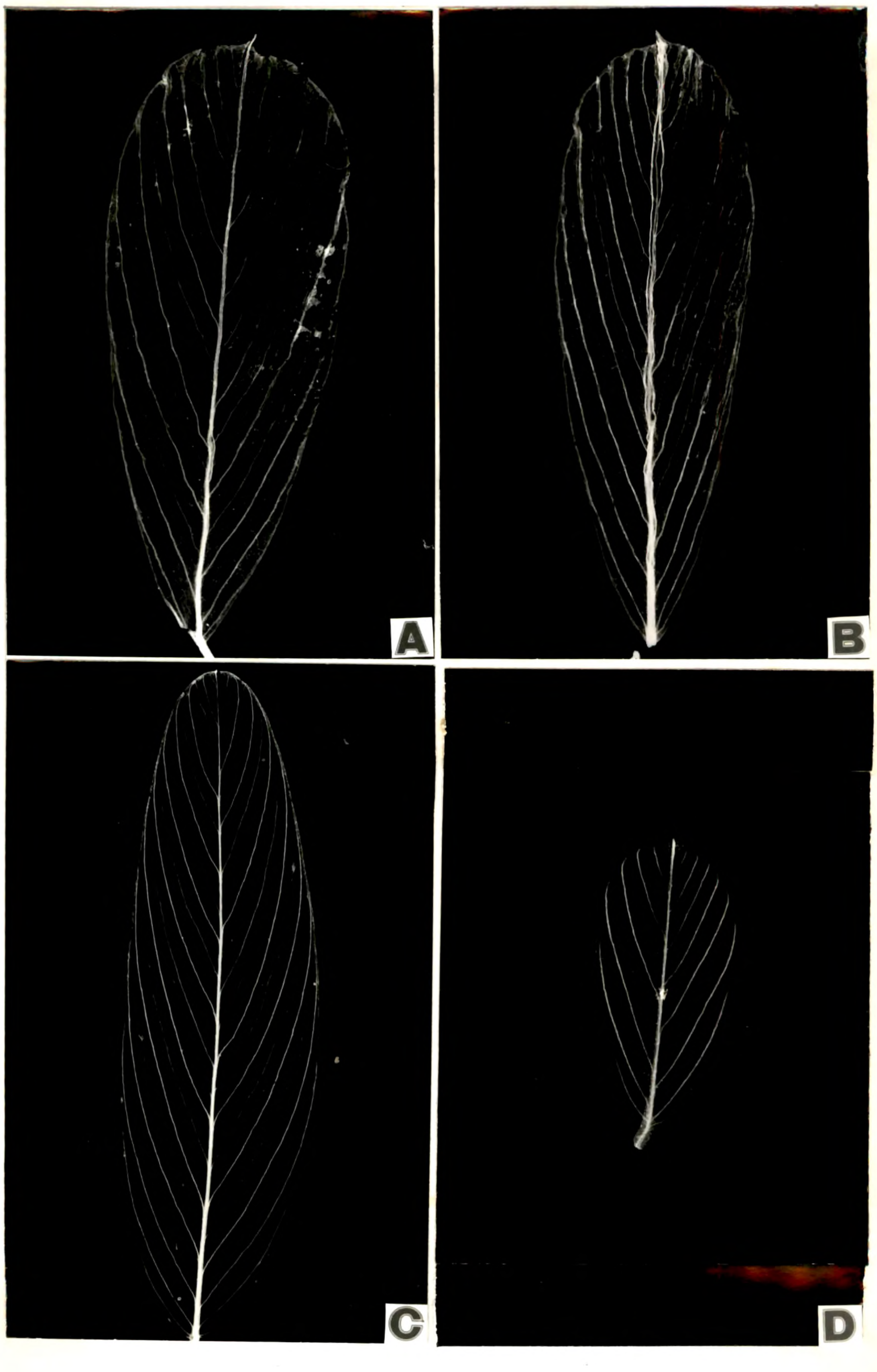

PLATE 3:14

Plate 3:15

Photomicrographs of cleared leaflets showing details of venation pattern.

Tephrosia falciformis

A - Marginal ultimate venation, areoles and veinlets.

T. subtriflora

B - Marginal ultimate venation, simple and branched vein endings.

C - Marginal ultimate venation, simple and branched vein endings.

T. uniflora subsp. petrosa

D - Variously oriented rectangular areoles.

T. candida

E - Uni, bi and multiseriate trachieds, loop formation.

F - Multiseriate trachieds and isolated trachied (it.).

Magnifications

A, D X48
B, C X73
E X140
F X165

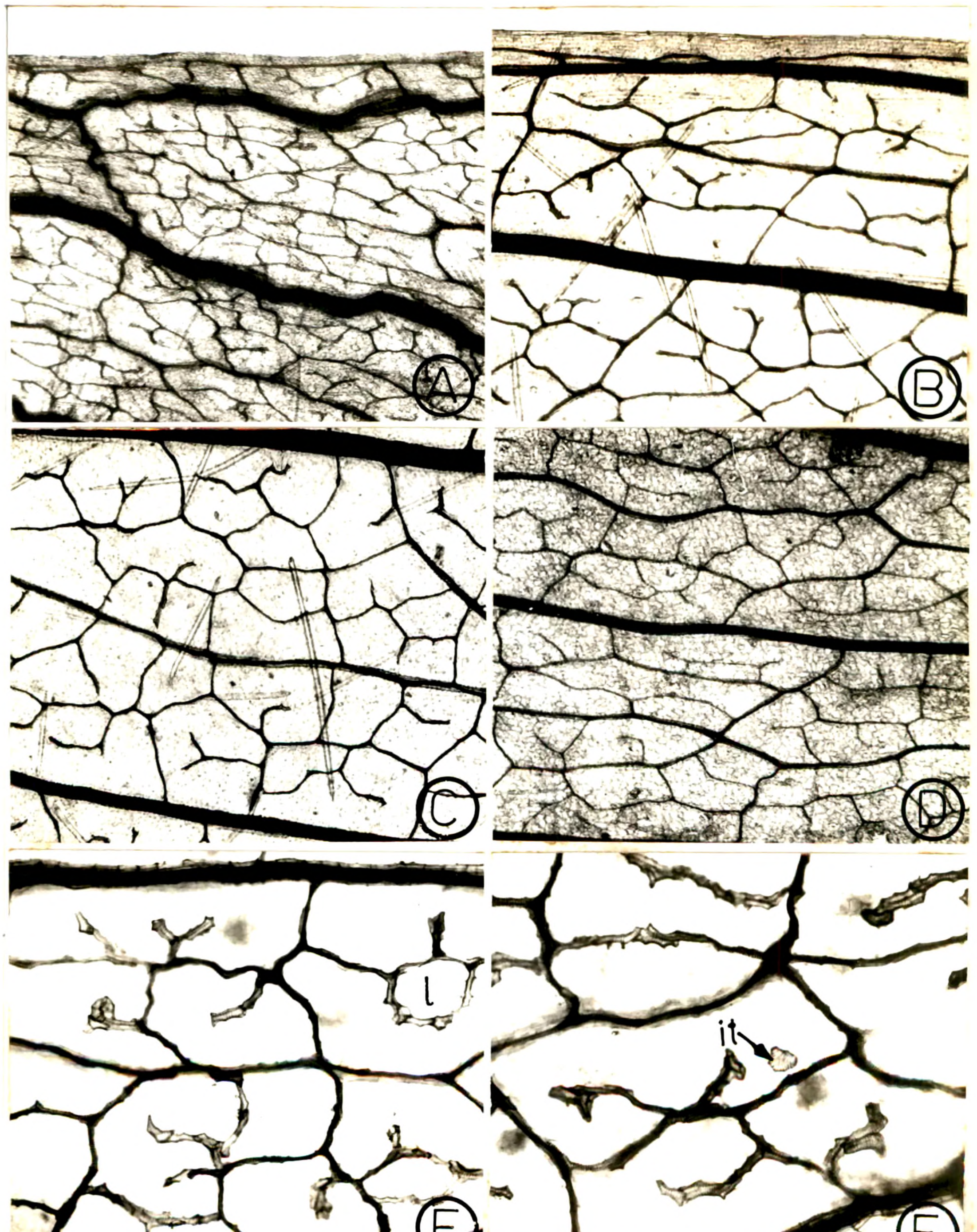

PLATE 3:15

Plate 3:16

Photomicrographs of cleared leaflets showing details of venation pattern.

Tephrosia strigosa

A - Loop formation.

T. pumila

B - Loop formation and distinct bundle sheath at vein endings.

C - Uniseriate trachied at vein ending.

T. falciformis

D - " " " " "

E - Uniseriate trachied at vein ending (in pair).

T. pumila

F - Biseriate trachied at vein ending and distinct bundle sheath.

T. falciformis

G, H - Differently oriented groups of trachieds at vein endings.

Magnifications

A, B	X300
C, G	X755
D	X937
E, H	X1074
F	X800

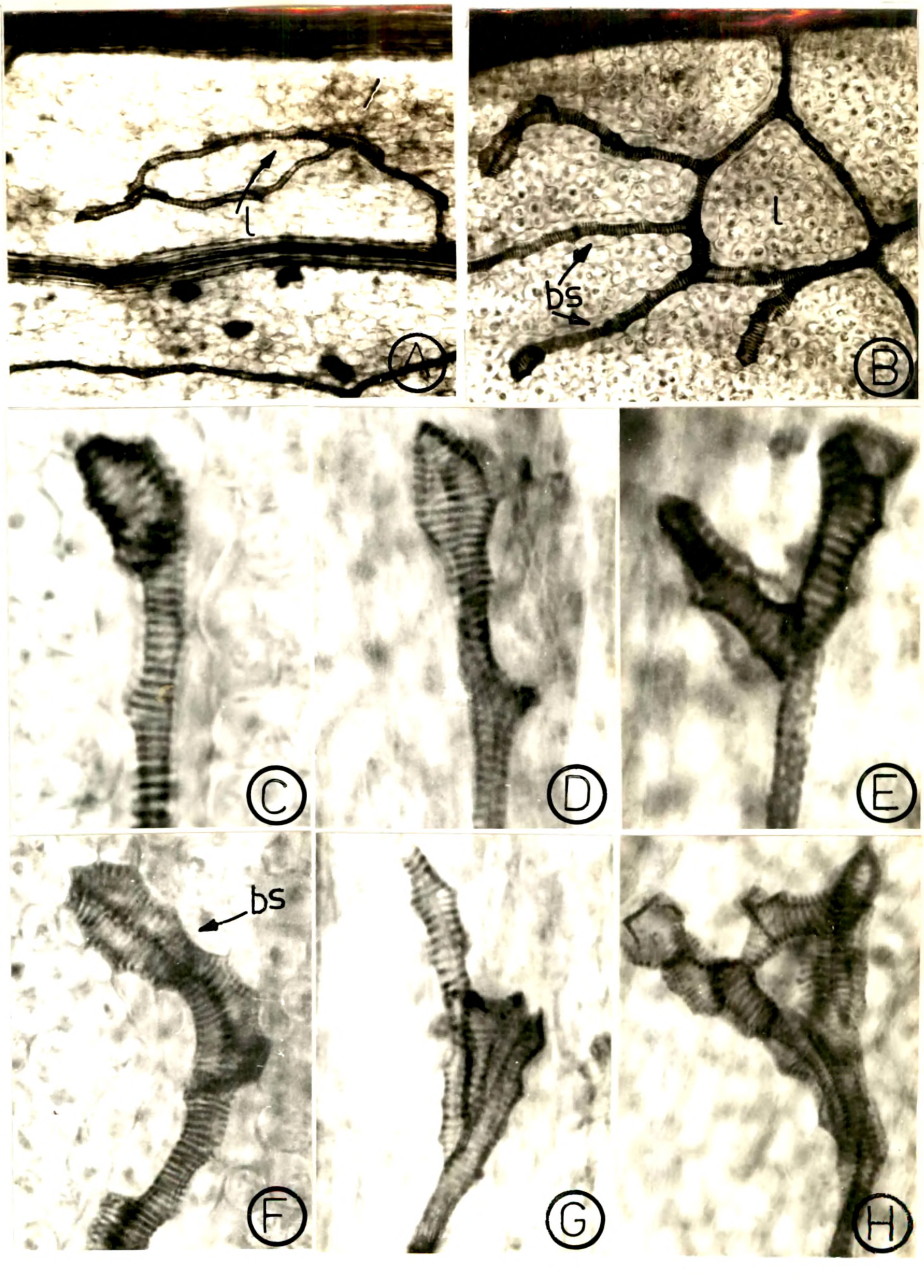

PLATE 3:16