ILLUSTRATIONS OF ANATOMY

OF

JOINTED CACTUS.

PHOTOGRAPHS AND DRAWINGS

BY

E. E. A. ARCHIBALD.

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Fig 1. Jointed Cactus on commonage at Uitenhage.

Fig 2. Close view of plant showing jointed stems, areoles, thorns and new growth (?). (Photo taken November).

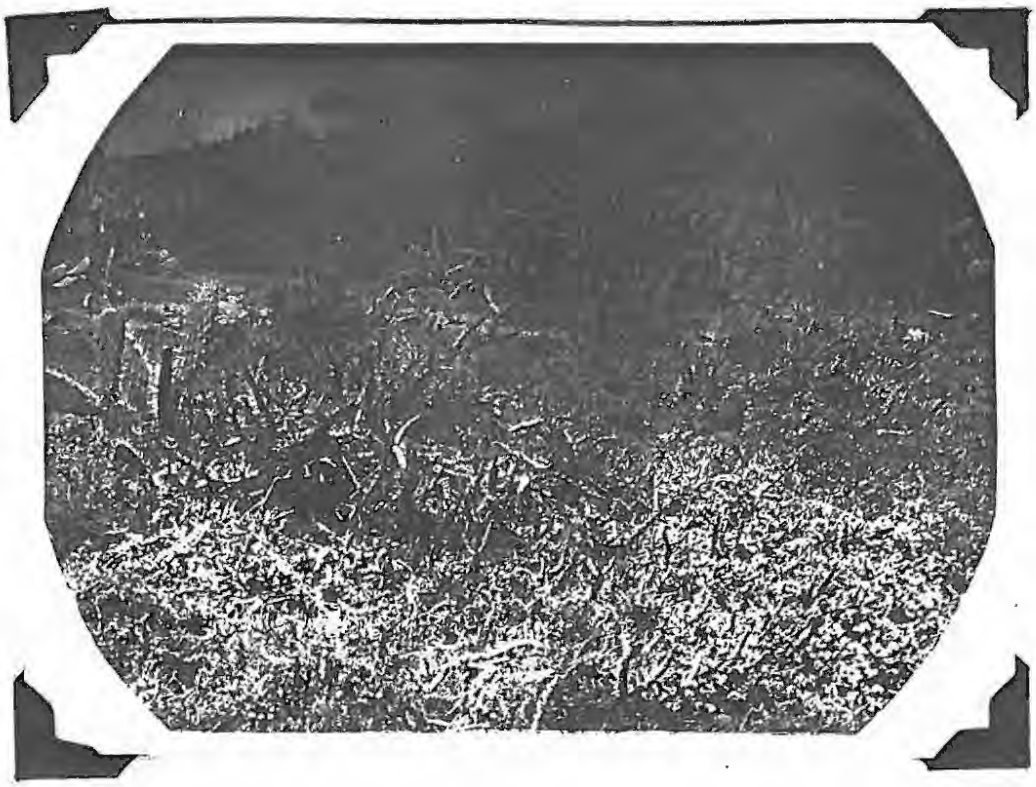


Fig. 1.

Fig. 2.

Fig.3a. Long main joint bearing several shorter joints and fruit, f.

Fig.3b. Plant from vegetatively propagated joint.

Fig.3c. ~~Flower~~. Young flower(f), and vegetative (v) buds. areole (a)

Fig. 3a.

Fig. 3b.

Fig. 4a. Joint bearing fruit and a young shoot.

Fig. 4b. Flower (natural size).

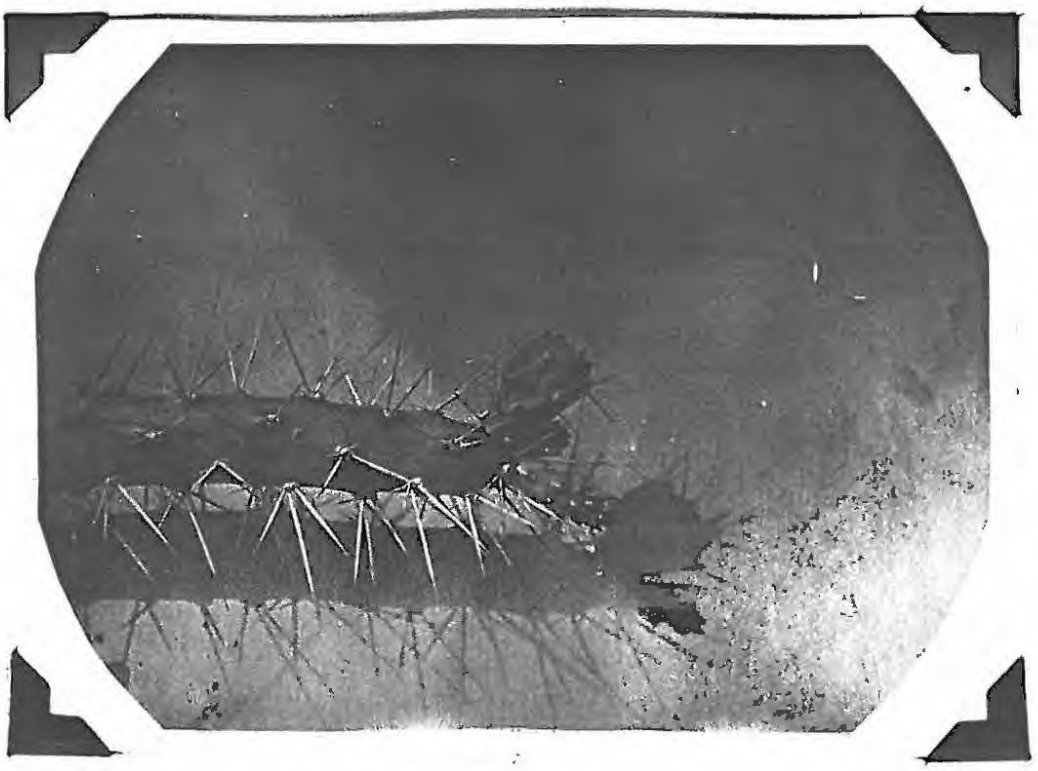


Fig 5a. Very young joint bearing leaves.

l. leaf; t. tubercle, (swollen part of joint at base of leaf).
a. areole; th. first thorns

Fig 5b. Tubercle and leaf.

t. tubercle; l. leaf; th. first two thorns on either side of leaf; th_2. third thorn in centre of areole; tr. trichomes.

Fig 6. Tip of thorn showing cells projecting outwards to form barbs.

Fig 7. Young flower bud.
s.sepals; ov. ovary wall; a. areole; l.leaf; th. thorn.

Fig 8a. Fruit. x1½

Fig 8b. Fruit cut open.
a.areole; th.thorn; b.bristles; ov.ovary wall; t.top of ovary; o.ovary cavity; s.seeds in mass inside ovary.

Fig 8c. Withered perianth attached to cone-like base formed by the abscission of the top of the receptacle.

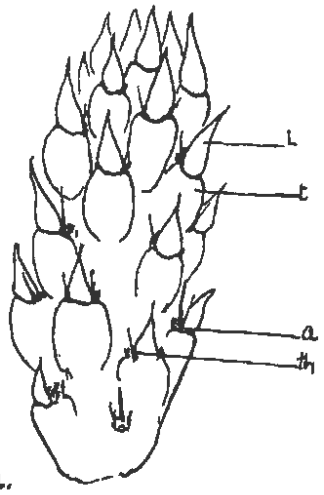


Fig. 5a.

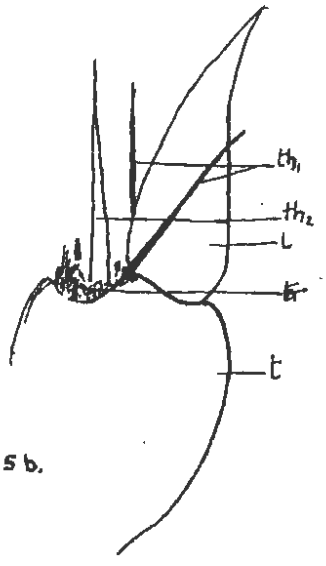


Fig. 5b.

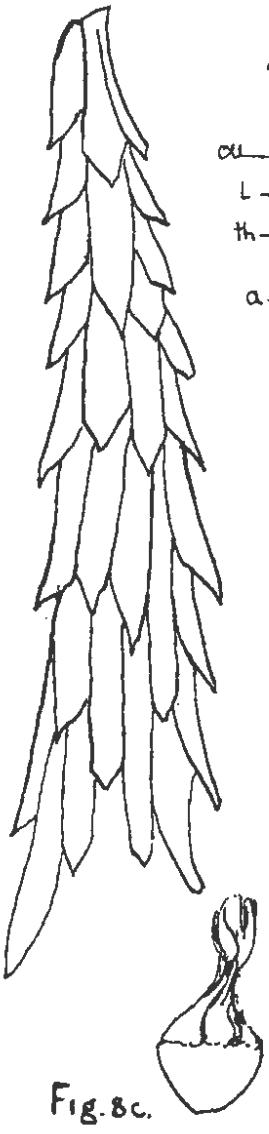


Fig. 6.

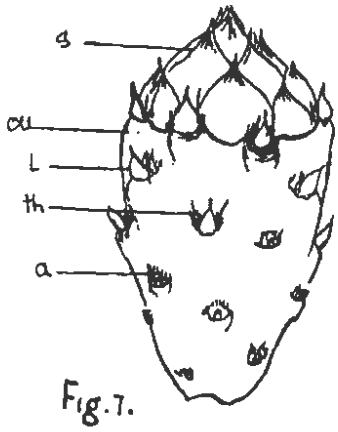


Fig. 7.

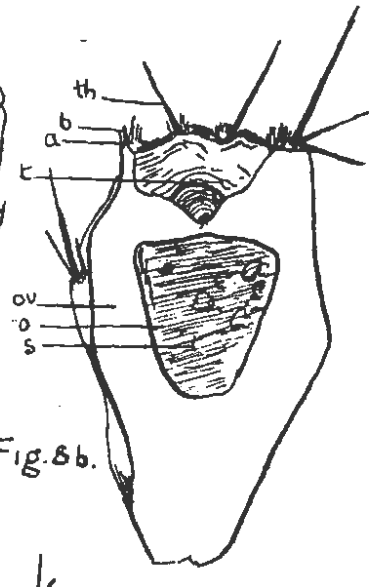


Fig. 8b.

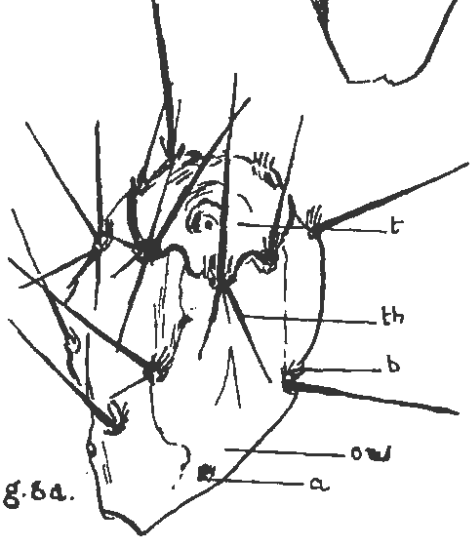


Fig. 8a.

Fig. 8c.

Fig 9. Longitudinal section of young vegetative bud. x50

gp. growing point; l. leaf; co. calcium oxalate crystals.

Fig 10. Longitudinal section of growing point of vegetative shoot. x150

gp. growing point; th. thorn from developing areole; vl. vascular bundle of leaf; t.tubercle, the swollen portion of the joint at the base of the leaf in the young joint.

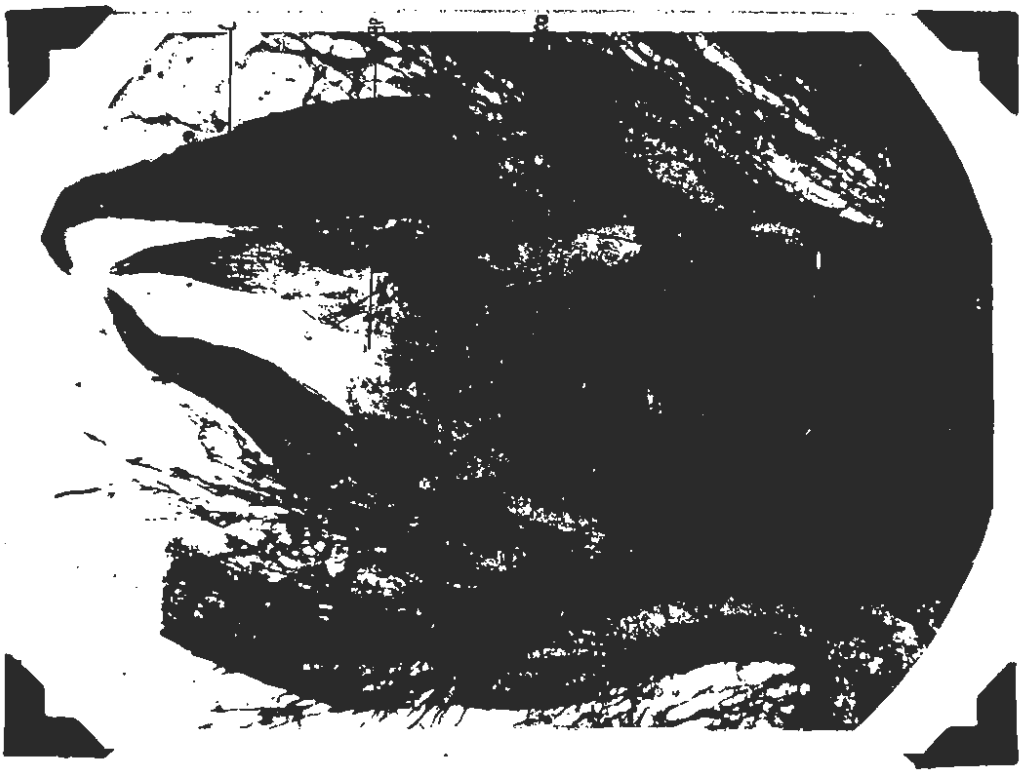


Fig 9.

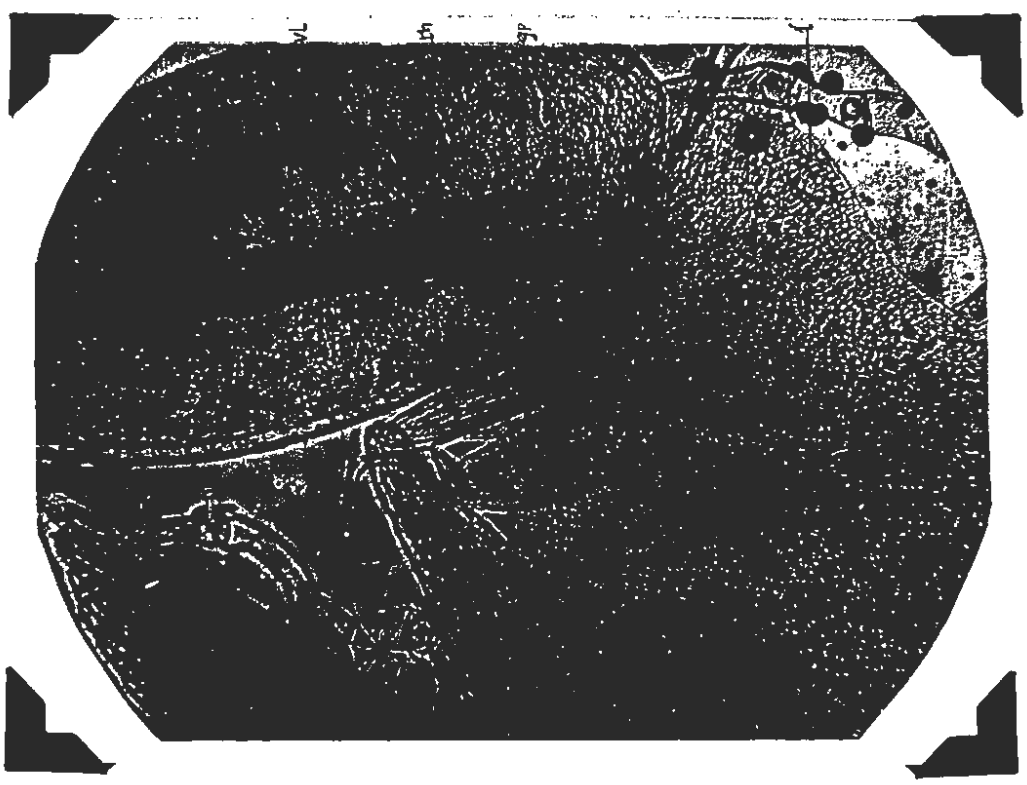


Fig 10.

Fig 11. Tangential section of leaf and leafbase showing leaf abscission. X150.

a. region of abscission; vb. vascular bundle of leaf; l. leaf.

Fig 12. Longitudinal section of well developed aroele. X50

th. base of thorn; tr. trichomes; b. bristle
cl. layer of cork beneath areole appendages.
m. meristematic tissue of areole;
co. calcium oxalate crystals.

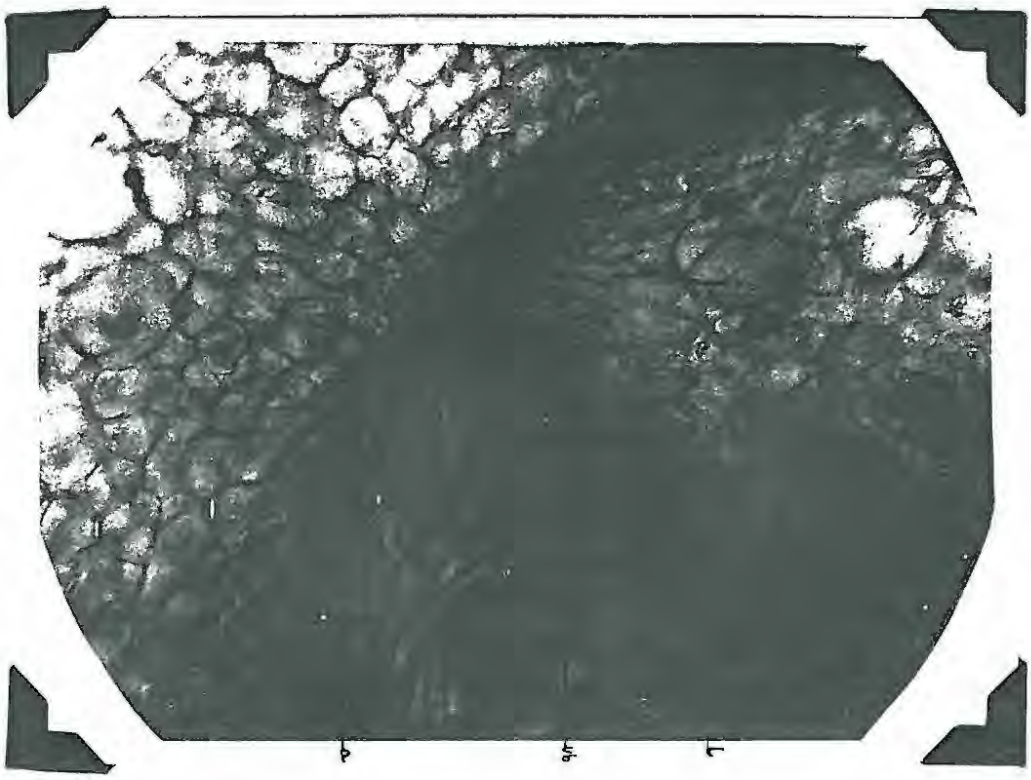


Fig 11.

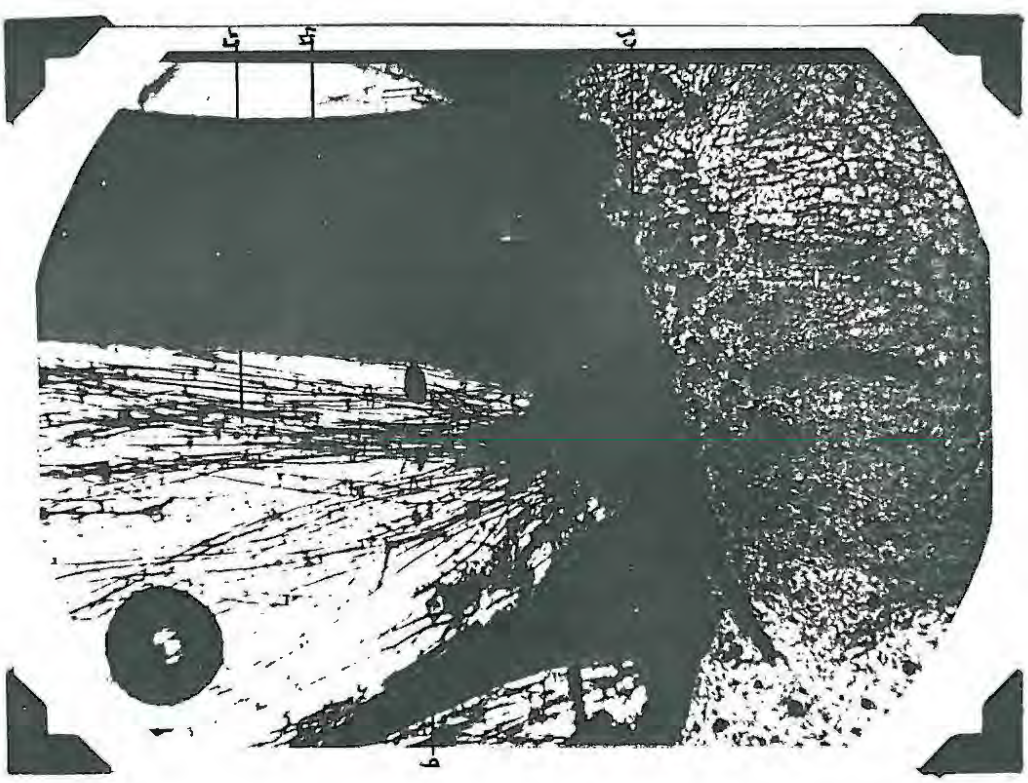


Fig 12.

Fig 13. Surface view of epidermis. X900

co. calcium oxalate crystals. These occur in the first layer of hypoderm below the epidermis, which is not separated from the hypoderm when stripped from the plant. The calcium oxalate seriously hinders the clarity of the view.

sc. subsidiary cell; gc. guard cell.

N.B. Stomata are shut.

Fig 14. Diagram of stoma showing surface and transverse views.

sc. sbsidiary cells; pr. projection of subsidiary cells above guard cells; pu. projection of sub.cells below guard cells; gc. guard cell p. closed pore; c. cuticle of epidermis; c_2. cuticle of respiratory ~~cavity~~ or sub-stomatal cavity.

pd. projection of subsidiary cells above stoma.

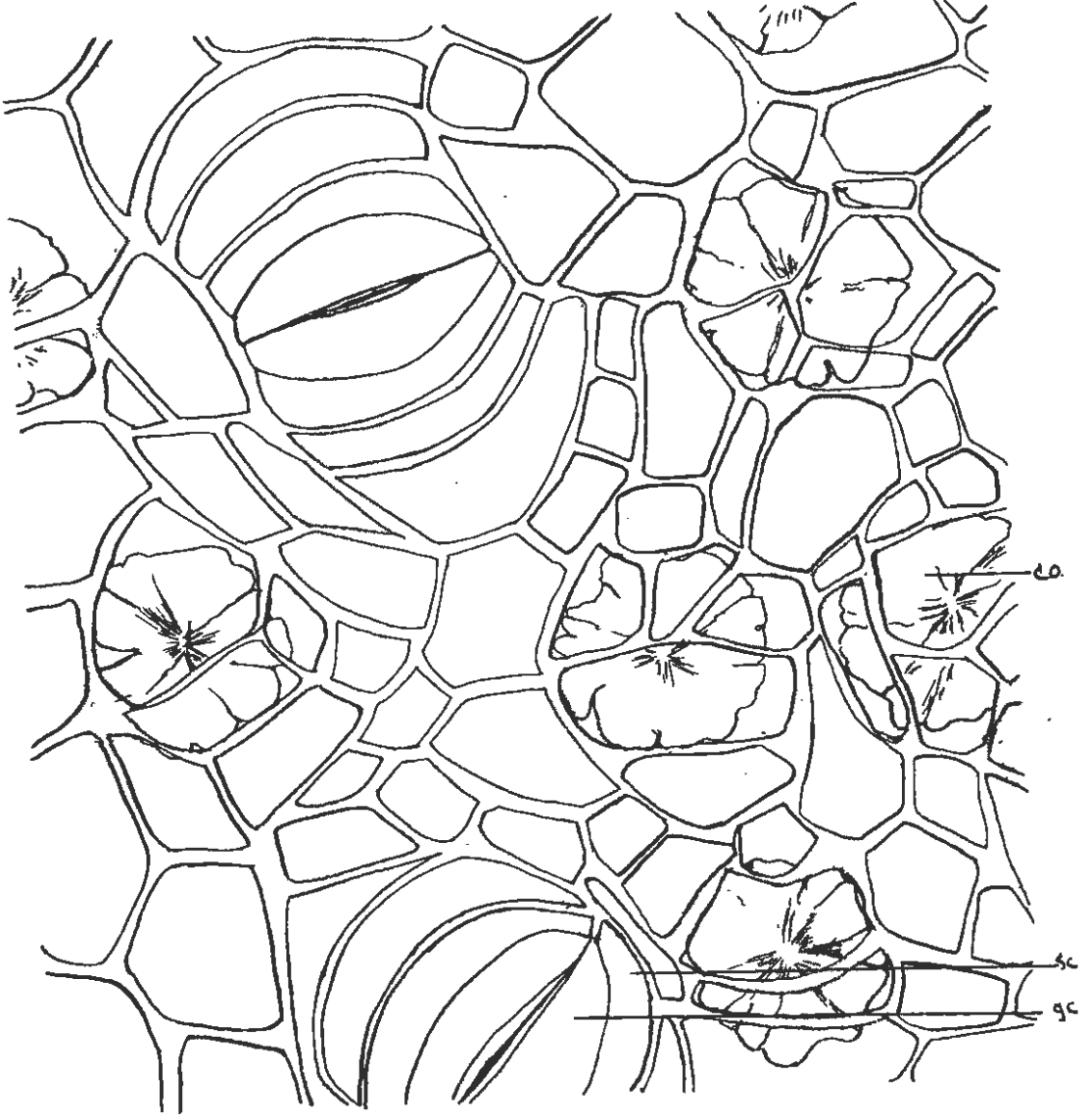


Fig 13.

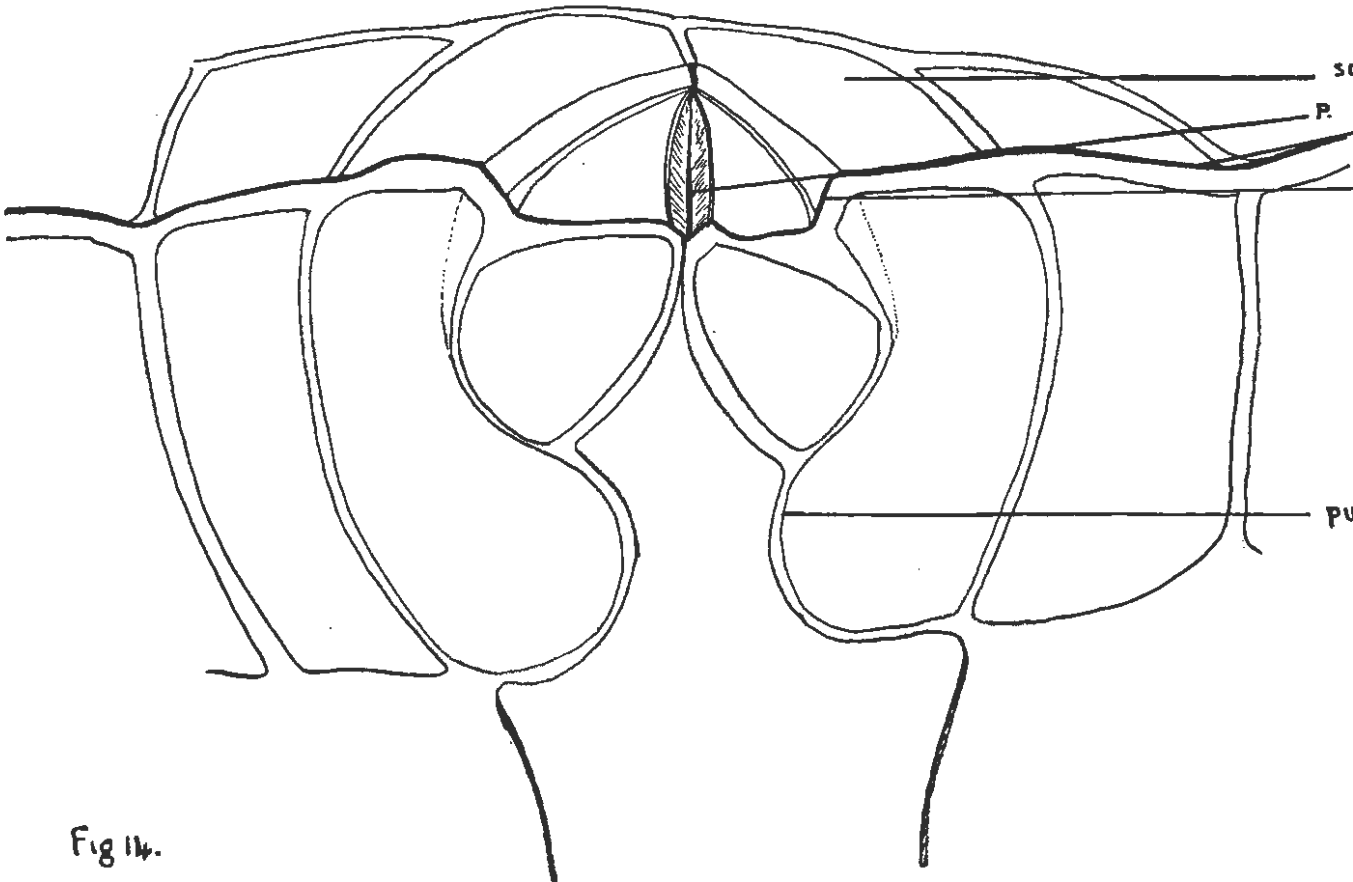


Fig 14.

Fig 15. Transverse section of young joint. X 160.

h. hypodermis, walls not yet thickened; cl. assimilating tissue of cortex; vb. vascular bundle; m. mucilage cell of medulla; m_2. mucilage cell of cortex.

Fig 16. T.S. of vascular bundle of young joint. X 700

ph. phloem; px. protoxylem; mc. possible lysogenous origin of mucilage canal.

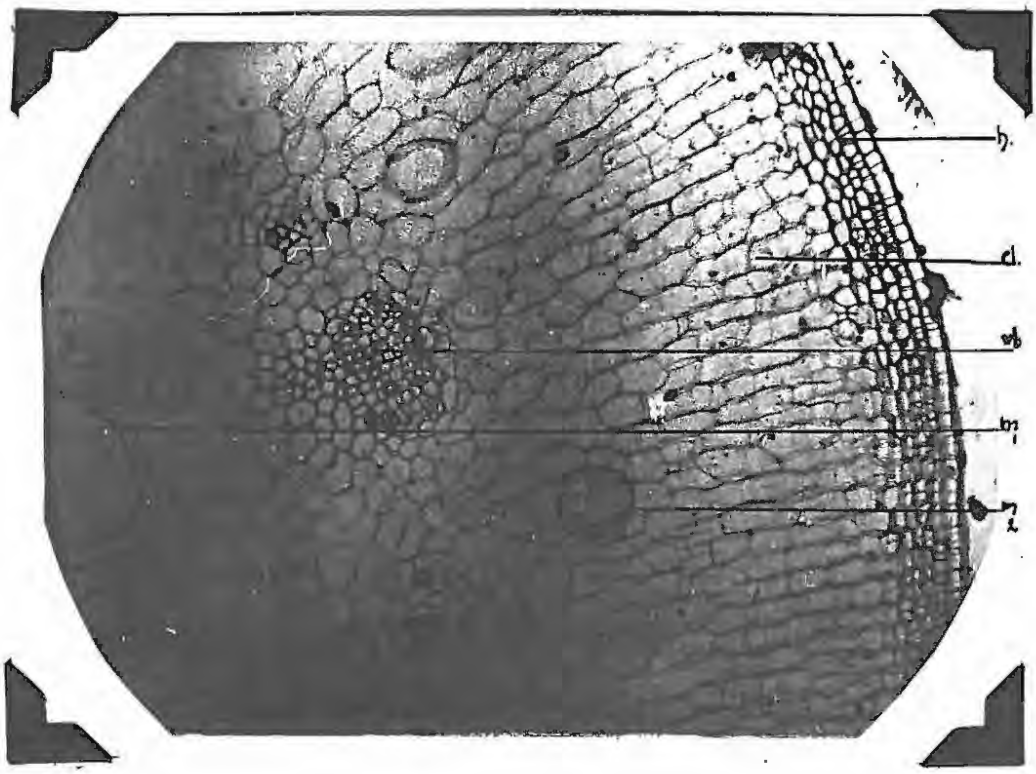


Fig 15.

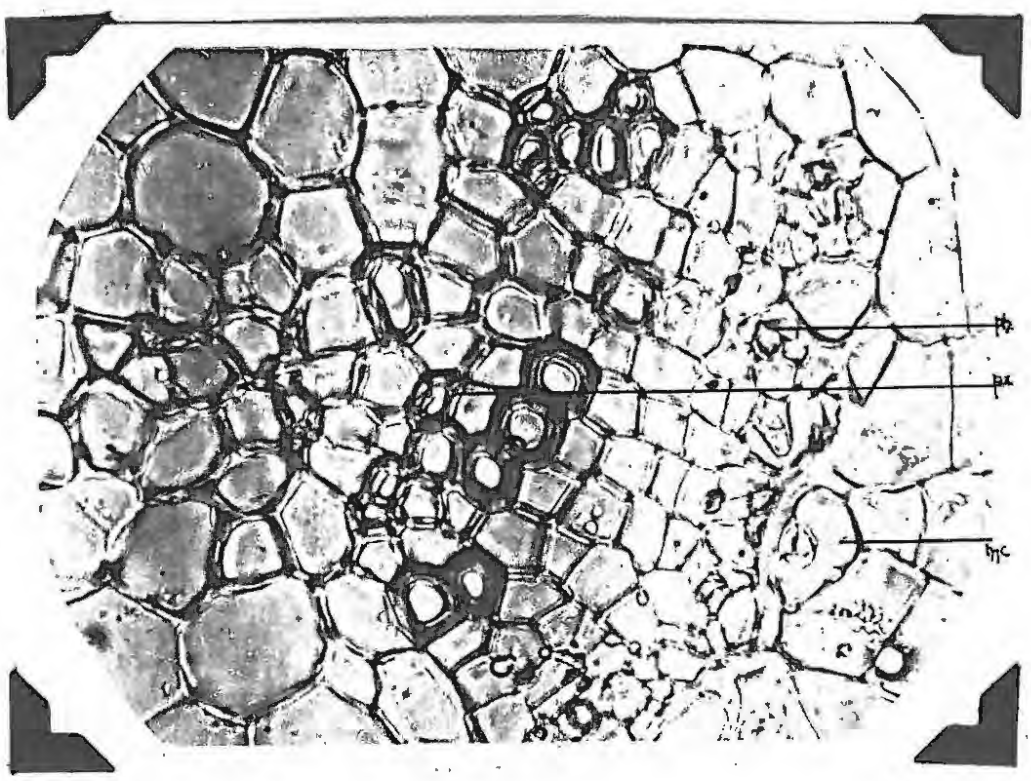


Fig 16.

Fig 17. T.S. stage I of developing stoma. Mother cell has divided to give potential guard cells. g.c. ×700

sc. subsidiary cells; rc. schizogenous formation of respiratory cavity; h. hypoderm, thickening of cell walls commencing.

Fig 18. T.S. stage II of developing stoma ×700.

th. thickening of guard cells which now start to round off.
c. cuticle (slightly thicker than natural owing to focusing)

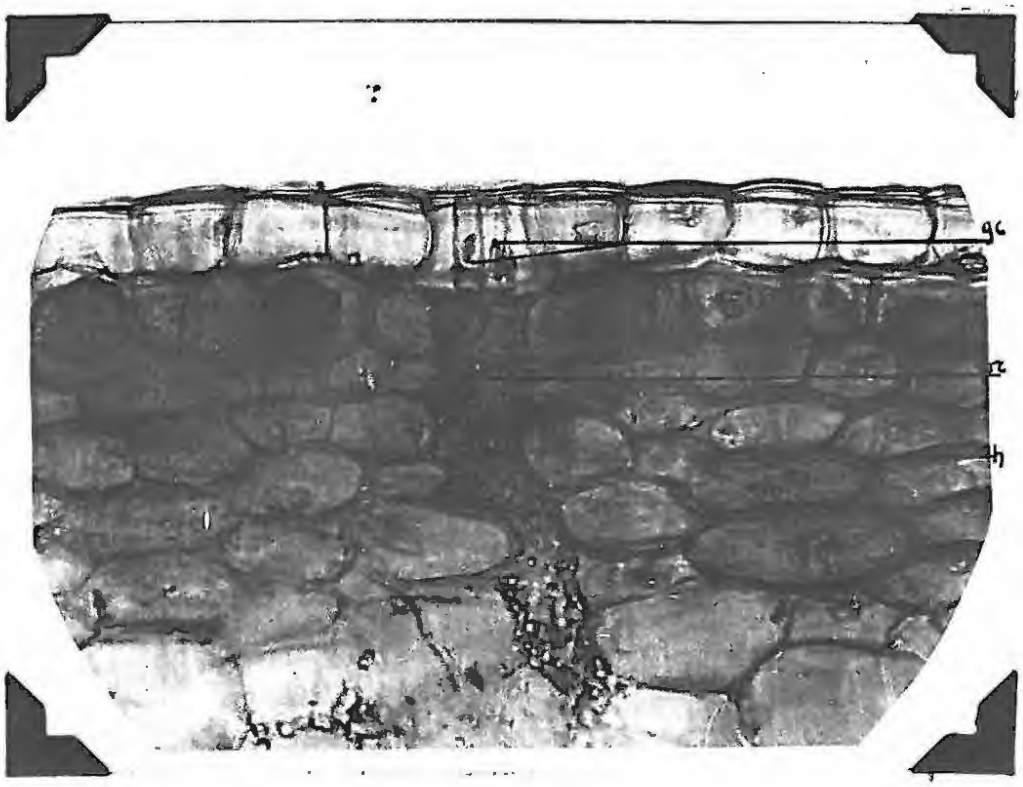


Fig 17.

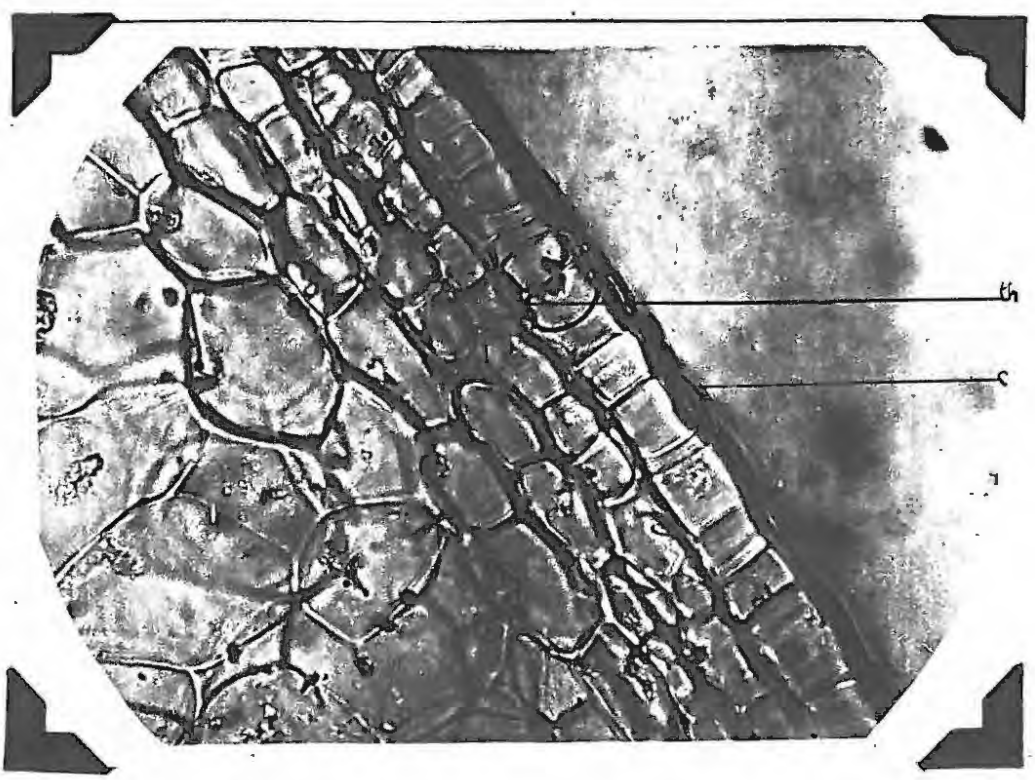


Fig 18.

Fig 19. T.S. stage III, developing stoma. x700
(Respiratory cavity does not show up very well.)

Fig 20. T.S. stage IV, developing stoma. x700

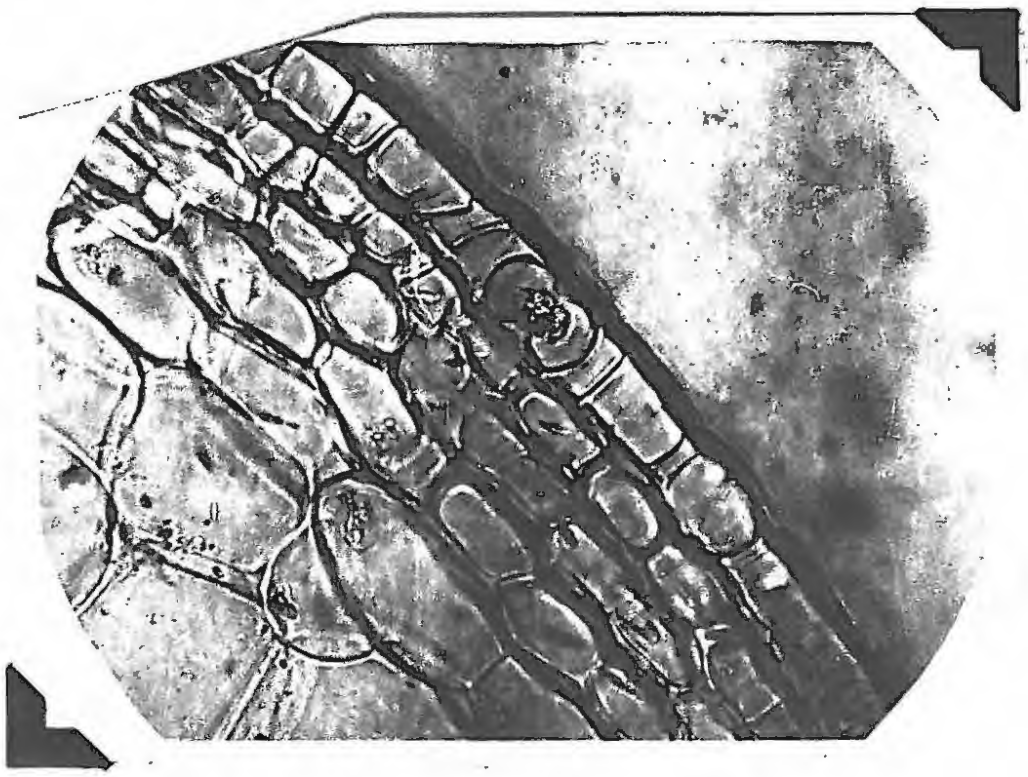


Fig 19.

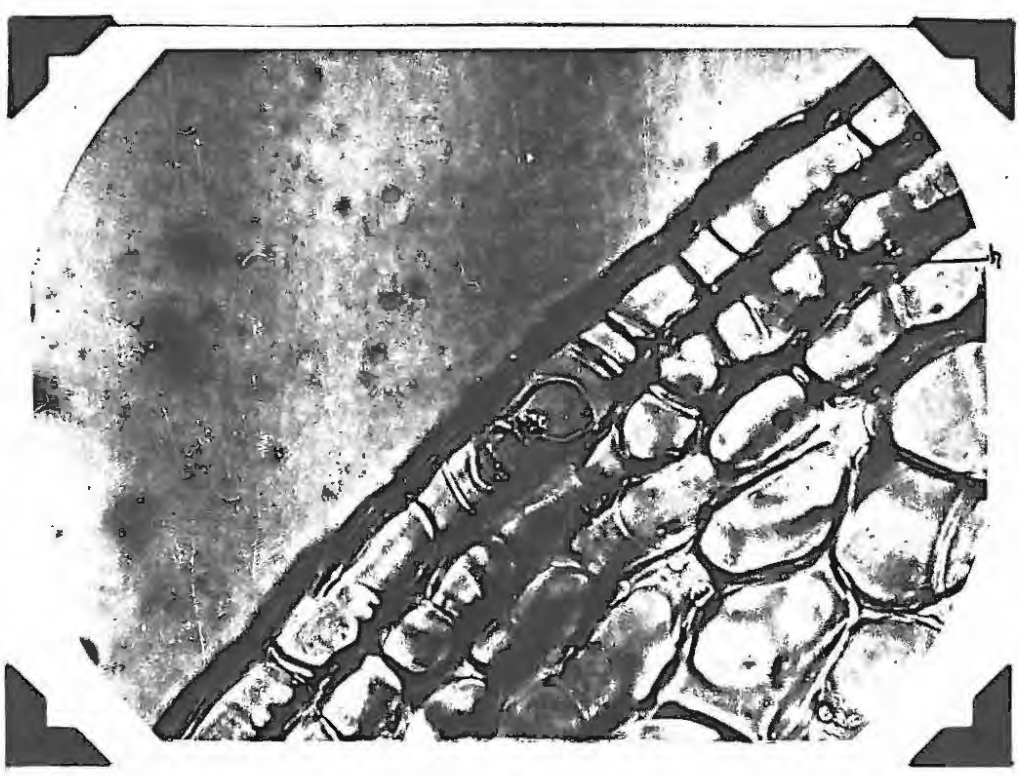


Fig 20.

Fig 22. T.S. of stoma of well developed joint. X700

g.c. guard cell; sc. subsidiary cell; co. calcium oxalate crystal in hypoderm below epidermis; h. collenchyma of hypoderm r.c. respiratory cavity; c. cuticle layer lining respiratory cavity; cx. first cells of cortex below hypodermis.

Fig 23. T.S. of stoma of old joint. X700

c. cuticle of epidermis, thicker than in fig 22; gcw. thickened wall of guard cell; sb. subsidiary cell growing in below guard cells; p. large simple pit in hypoderm collenchyma; tw. thickened wall of hypoderm

Fig 21.

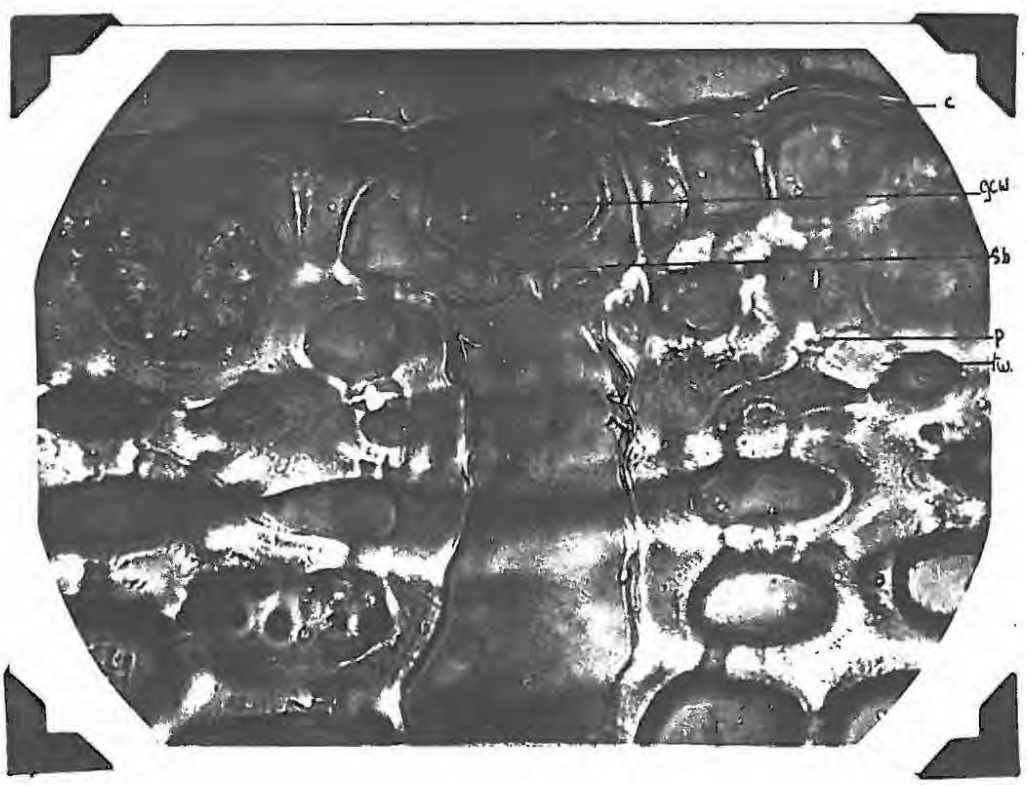


Fig 22.

Fig 23. Diagram of conducting system of joint in longitudinal view.

a. areole; e. epidermis on outside of joint. lt. leaf trace to areole; lj. joining of leaf trace; sv. secondary vascular strads to areole from main trace (These eventually will form the vascular supply to the new joint from the areole) tv. reticulation of tracheids between vascular strads

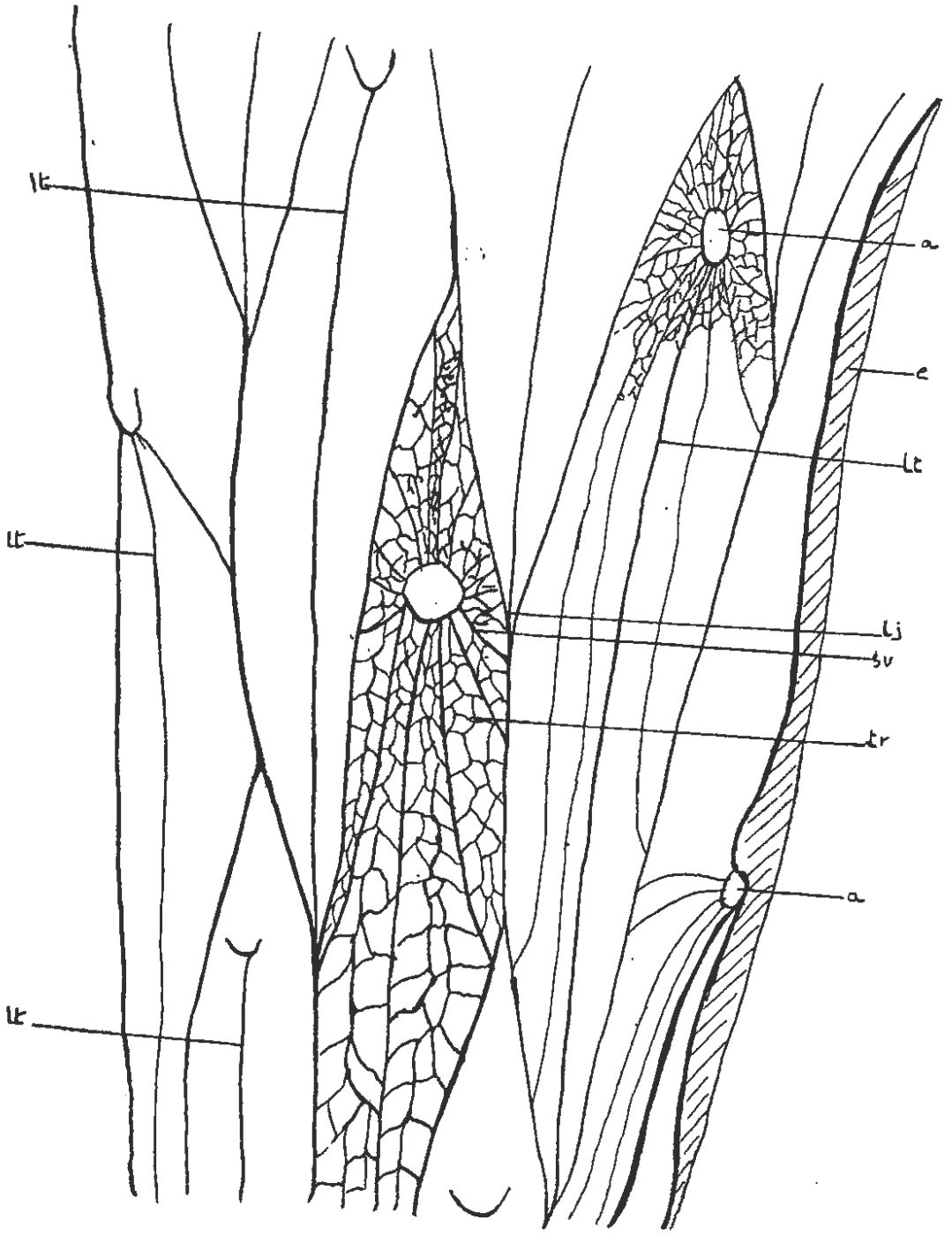


Fig 23.

Fig 24. L.S. of two vascular strands with reticulation of tracheids between. ×50
tr. tracheids; vb. vascular bundle;
co. calcium oxalate crystal.

Fig.25. Tracheids which form the reticulation between vascular strands. ×700
t. tracheid;
p. large celled parenchyma of ground tissue.

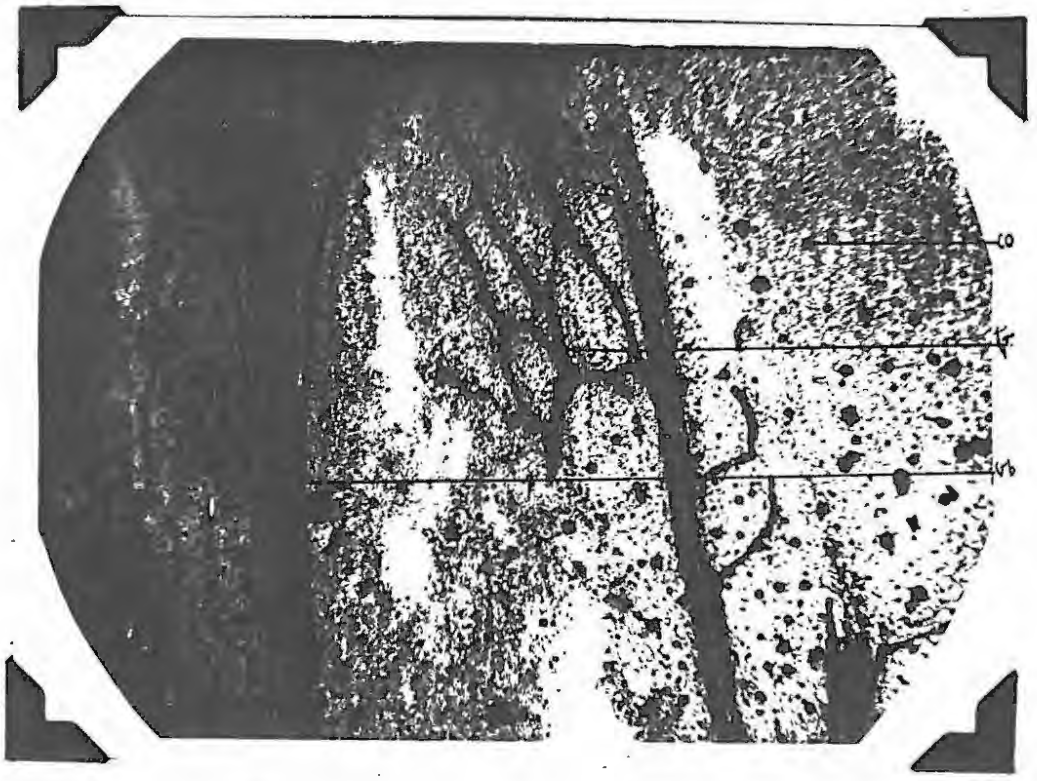


Fig 24.

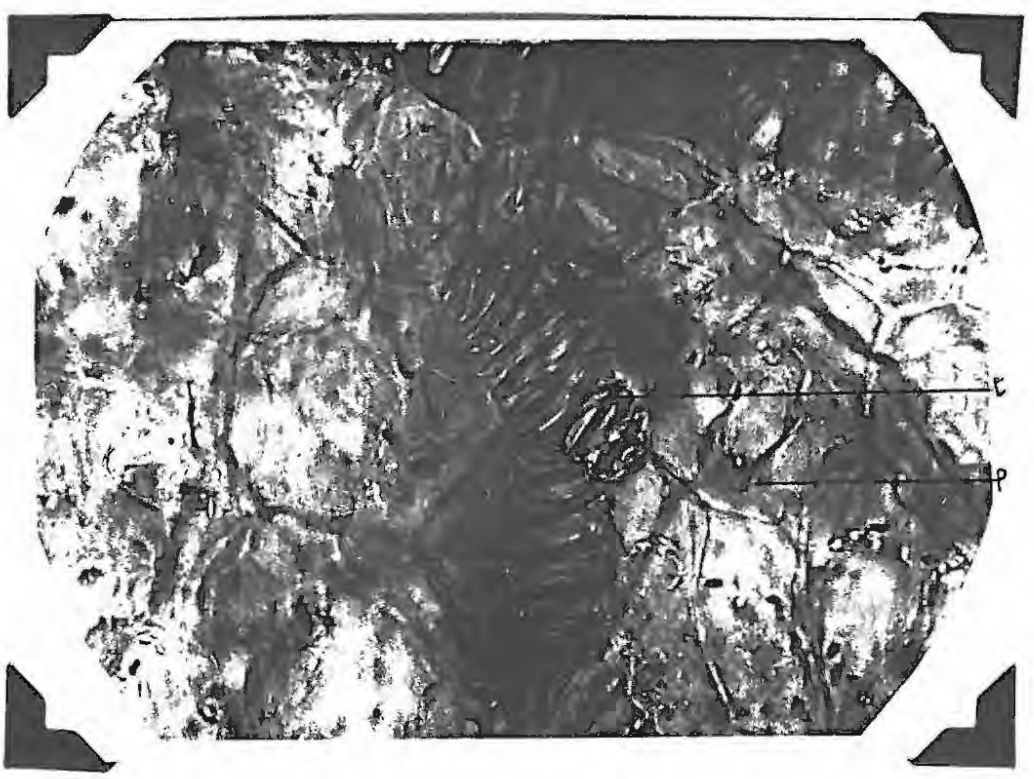


Fig 25.

Fig 26. T.S. of vascular bundle of well developed joint. (diagram)

c.o. calcium oxalate crystals in parenchyma around phloem.
p. phloem; ic. interfasicular cambium,
f.c. Fasicular cambium; sx, secondary xylem tracheae; wp. wood parenchyma; p.x. protoxylem mc. mucilage cell.

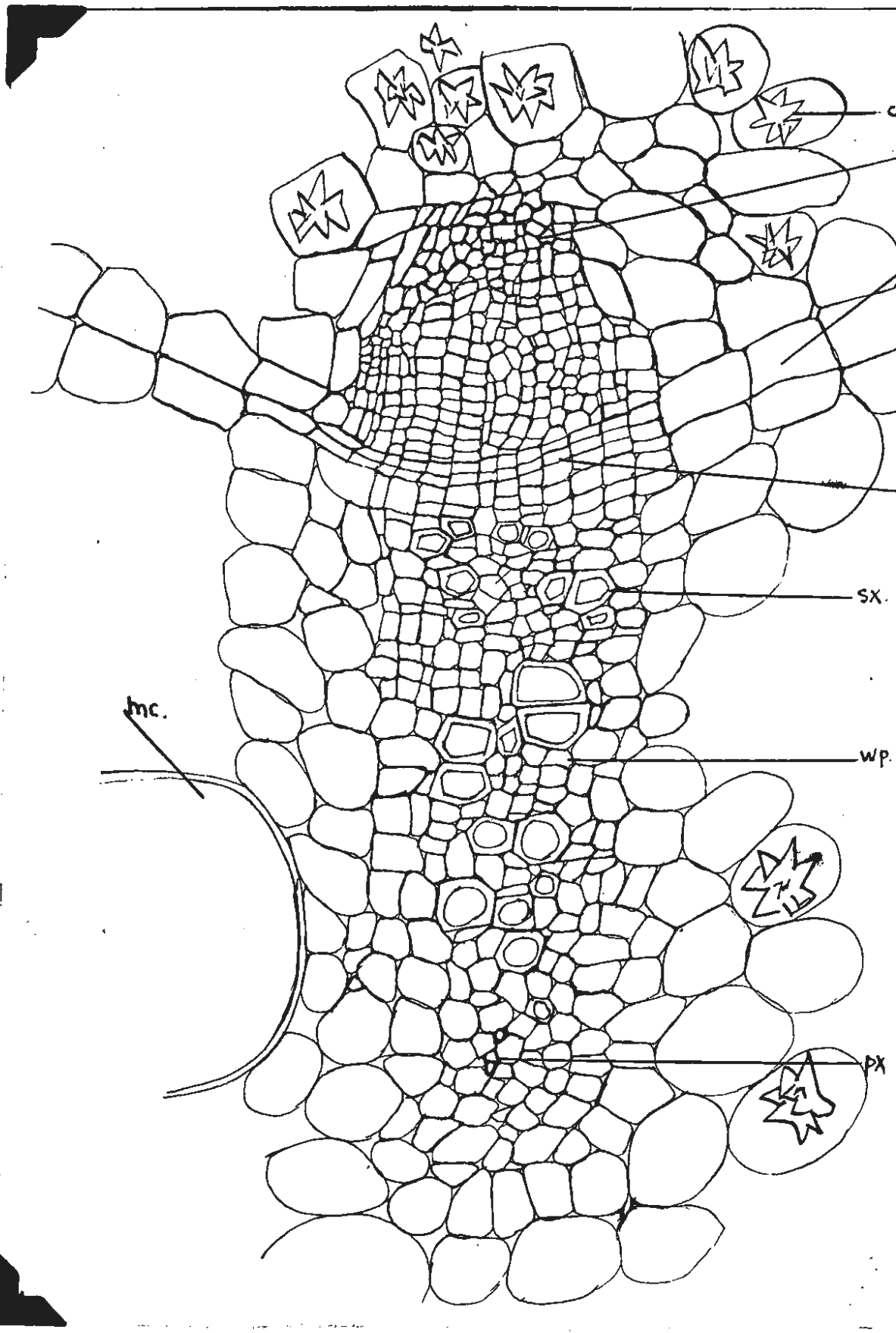


Fig 26.

Fig 27. L.S. vascular bundle of young joint of fig. 13. X150

co. calcium oxalate crystal; p. phloem;
v. annularly thickened vessel of metaxylem
xp. protoxylem.

Fig 28. L.S. vascular bundle of well developed joint. X150

hy. hydrocyte with 3 bands of thickening;
t. tracheid of secondary xylem; p. phloem;
cv. calcium oxalate crystal

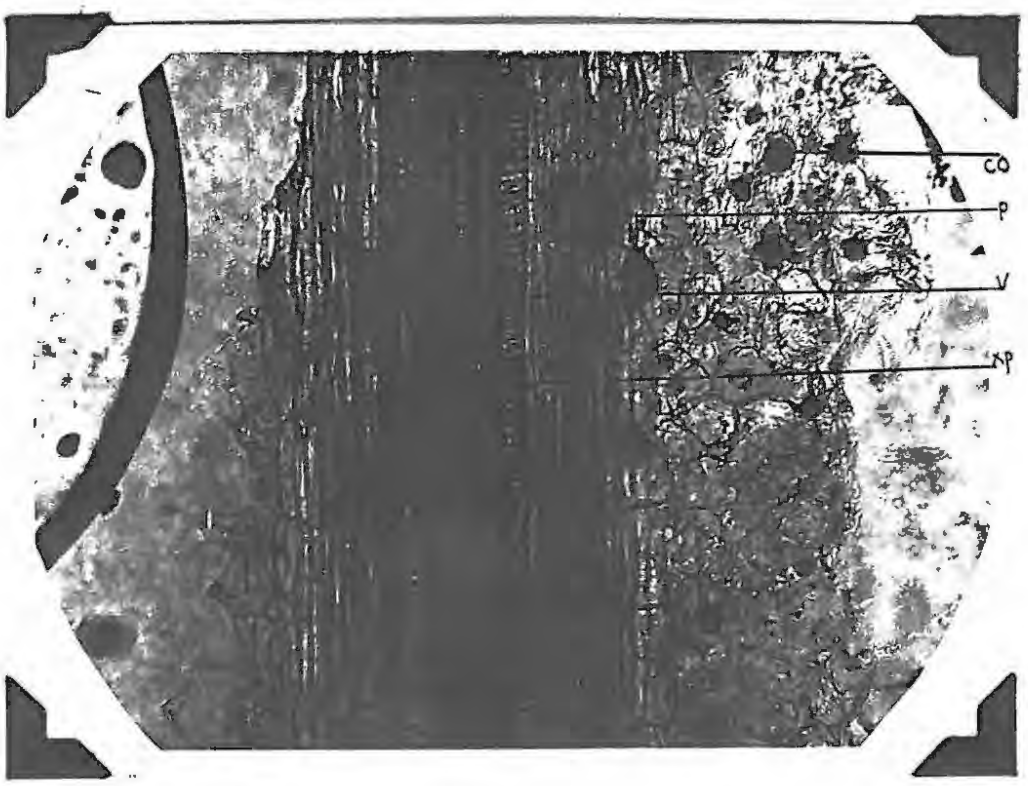


Fig 27.

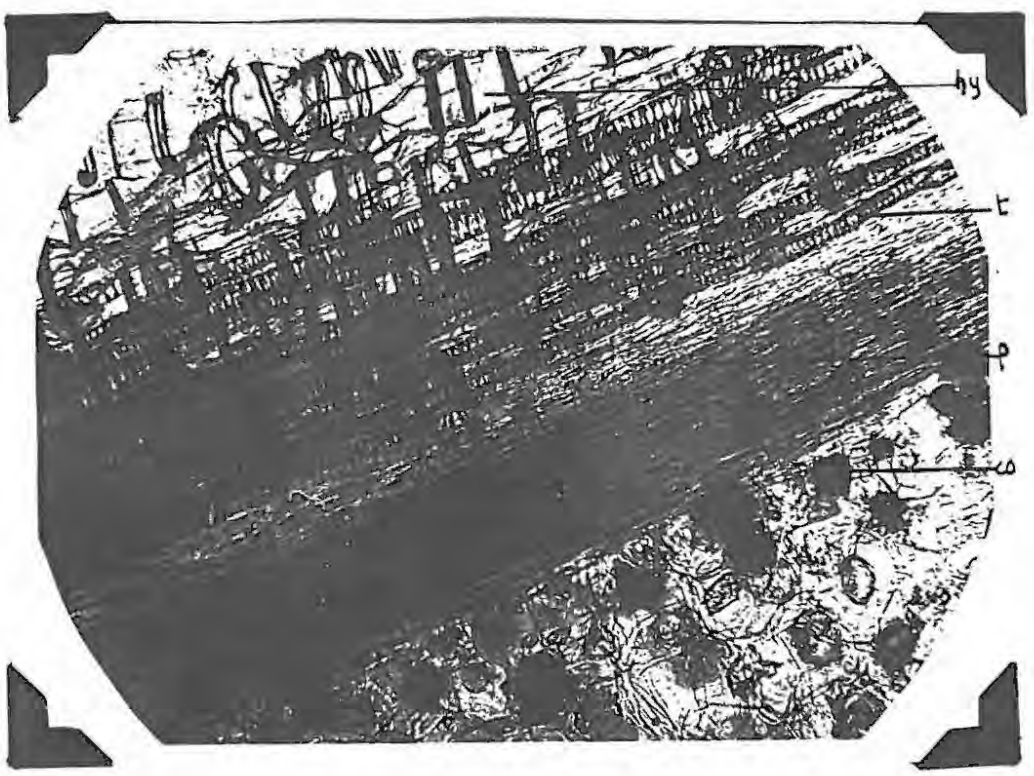


Fig 28.

Fig 29. T.S. vascular bundle of well developed joint.X50

ic. interfascicular cambium; in mucilage cell; p. phloem; fc. fascicular cambium; w.p. wood parenchyma; x. secondary xylem; px. protoxylem; hy. Hydrocyte in parenchyma outside bundle.

Fig 30. T.S. phloem and mucilage canal outside bundle.X150

co. calcium oxlate crystal; mc. mucilage canal; p. phloem; fc. fascicular cambium; s. starch grain in medullary parenchyma.

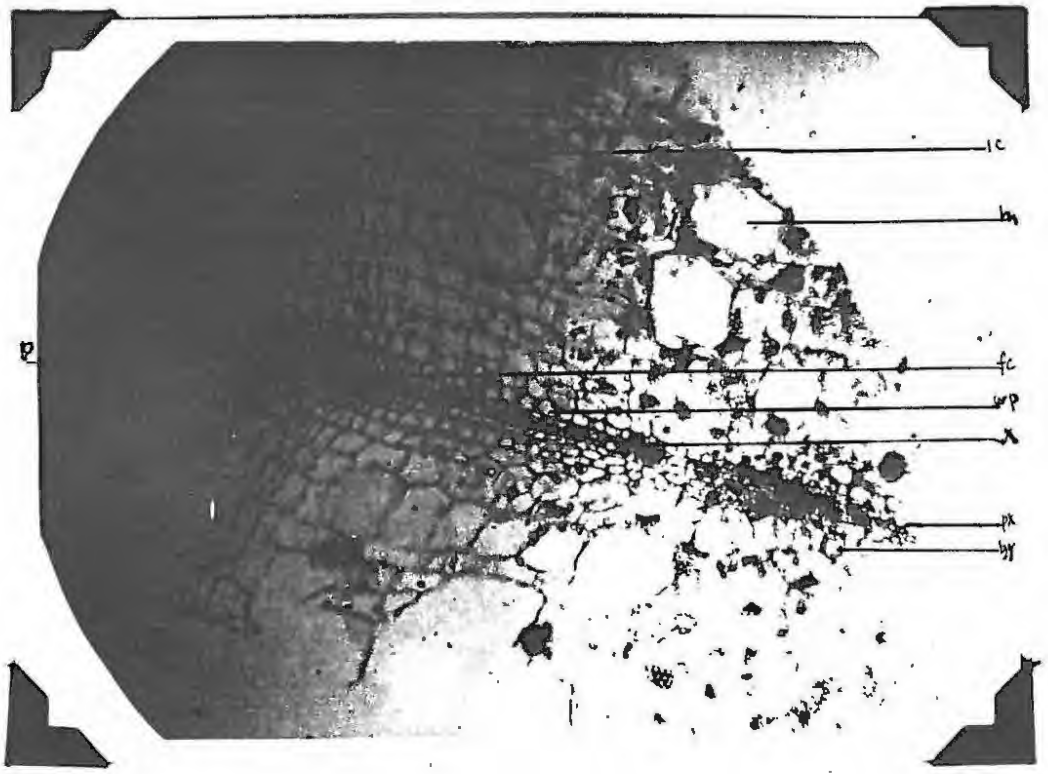


Fig 29.

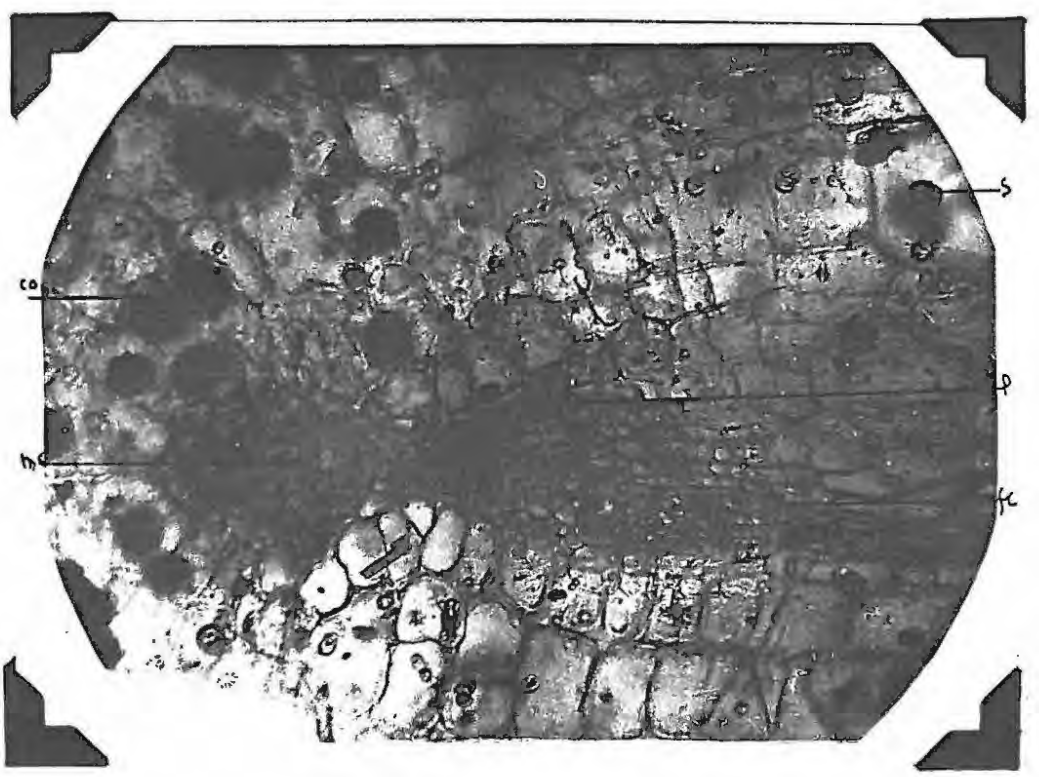


Fig 30.

Fig 31. T.S. stoma at commencement of cork formation. X700

h. hypodermis; ec. epidermis forming cork cambium; c. cuticle lining to respiratory cavity; rc. respiratory cavity; ds. dividing wall of subsid cell which is now taking part in cork formation of cork; co. calcium oxalate crystal in hypodermis below epidermis; gc. remains of guard cells.

Fig 32. T.S. cork formation in a tuber. X150

l. first liquified layer of cork; c. first suberised layer of cork; l_2. second liquified layer of cork; ec. epidermis transformed and acting as cork cambium; co. calcium oxalate crystal of the layer in hypodermis beneath epidermis; t. tyloses from subsidiary cell blocking respiratory cavity; rc. respiratory cavity; h. hypodermis; s. starch grains in cell cortex.

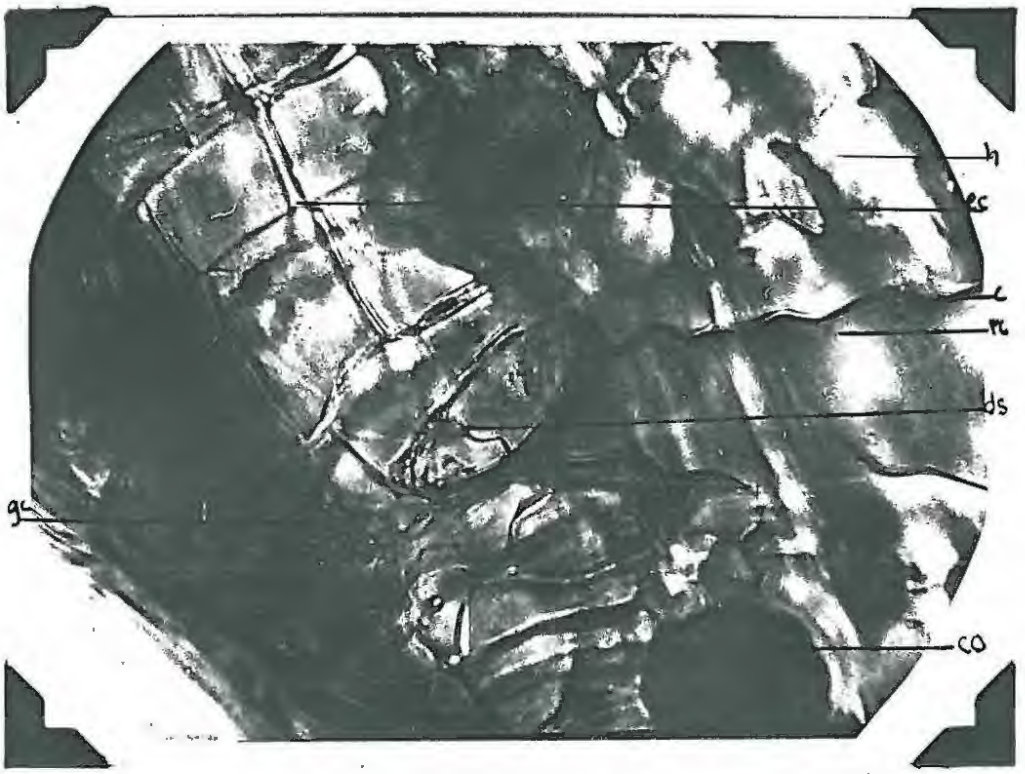


Fig 31.

Fig 32.

Fig 33. T.S. of tylosis blocking respiratory cavity.X700

s. portion of former subsidiary cell;
t. tylosis cell.
rc. respiratory cavity;
h. hypodermis.

Fig 34. T.S. of tyloses tissue blocking respiratory cavity. X700

tt. tyloses tissue; rc. respiratory cavity enlarged by expansion of joint.

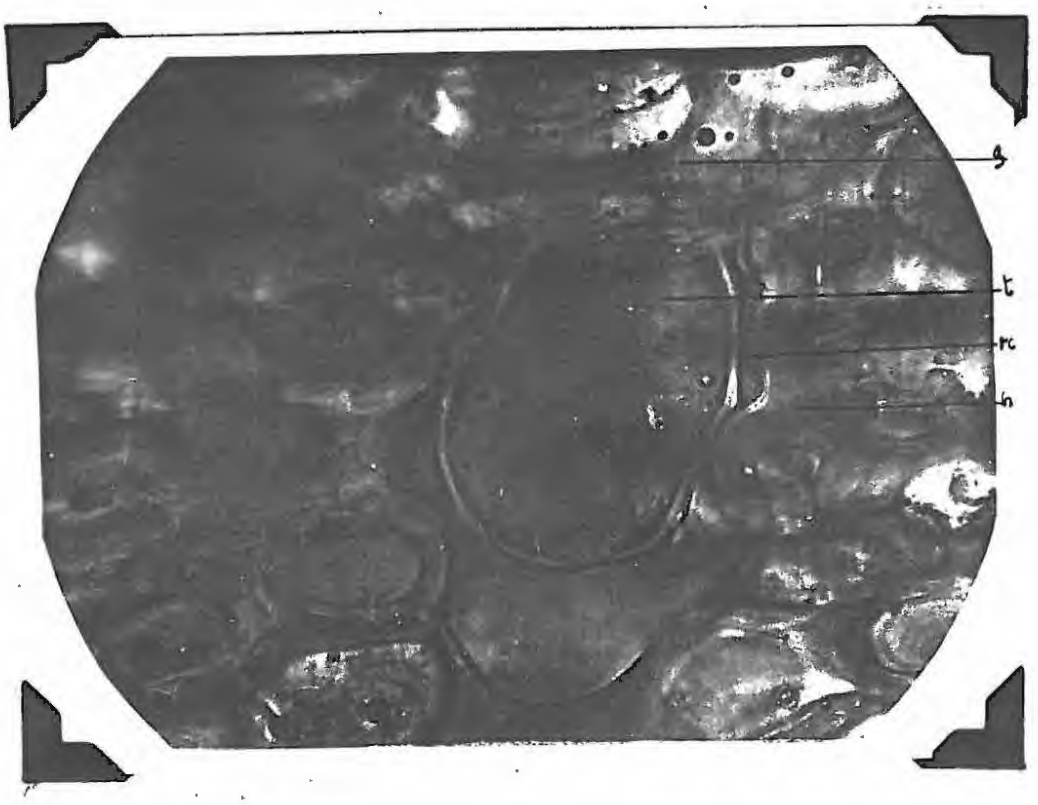


Fig 33.

Fig 34.

Fig 35. Series showing tuber formation from a joint. X½

Fig 36. ~~Large Tubers~~.
Vegetative propagation and tuber formation from fruit. X ½

Fig 35.

Fig 36.

Fig 39. T.S. vascular bundle of tuber.

ic. interfascicular cambium; mp. medullary ray parenchyma; wp. wood parenchyma;
x. secondary xylem elements;
hy. hydrocyte.

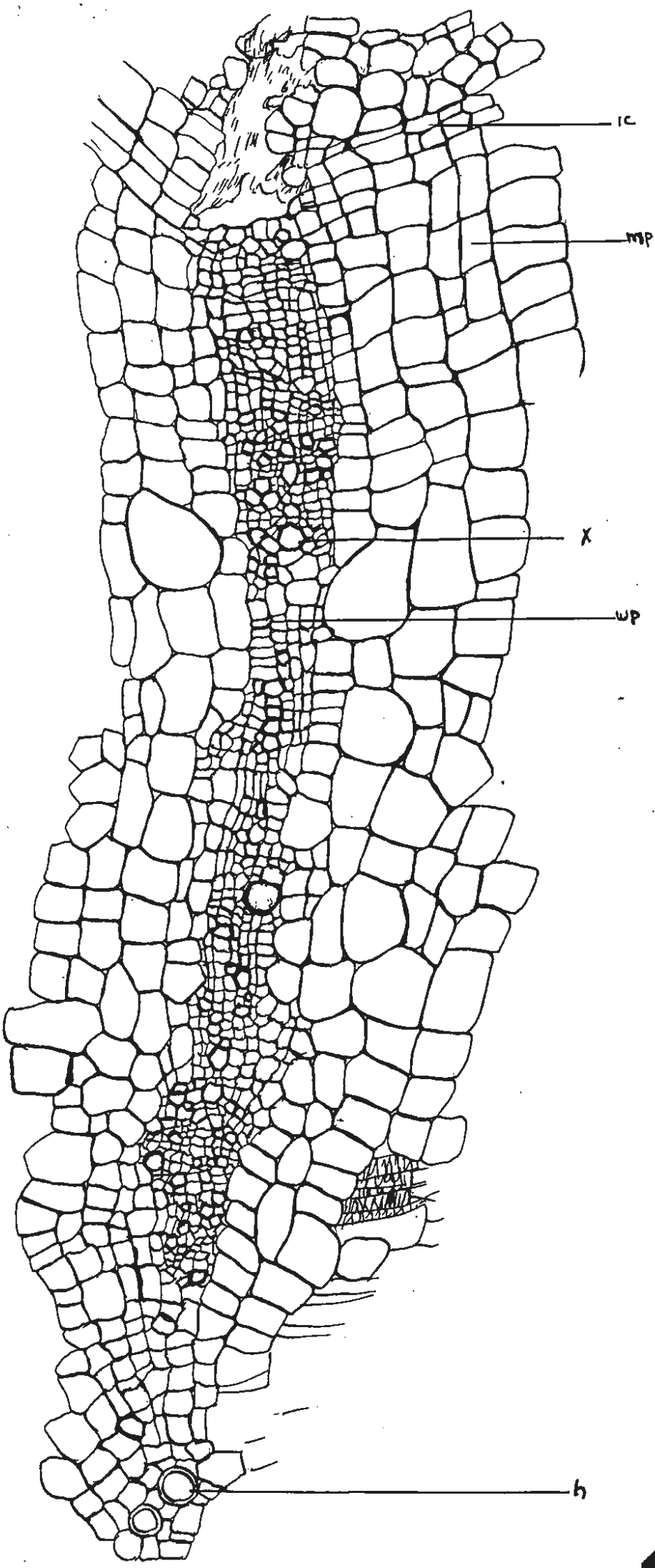

ic
mp
x
wp
h

Fig 40. T.S. of tuber. ×30

mc.mucilage canal; ic. interfascicular cambium; p. phloem; fc. fascicular cambium mp. medullary ray parenchyma; m. mucilage cell; f. fibres patch in elongated vascular bundle.

Fig 41. T.S. of mucilage canals in tuber. ×50

vm. mucilage in lysogenous canal;
co. calcium oxalate crystals.
p. phloem;
c.cortex.

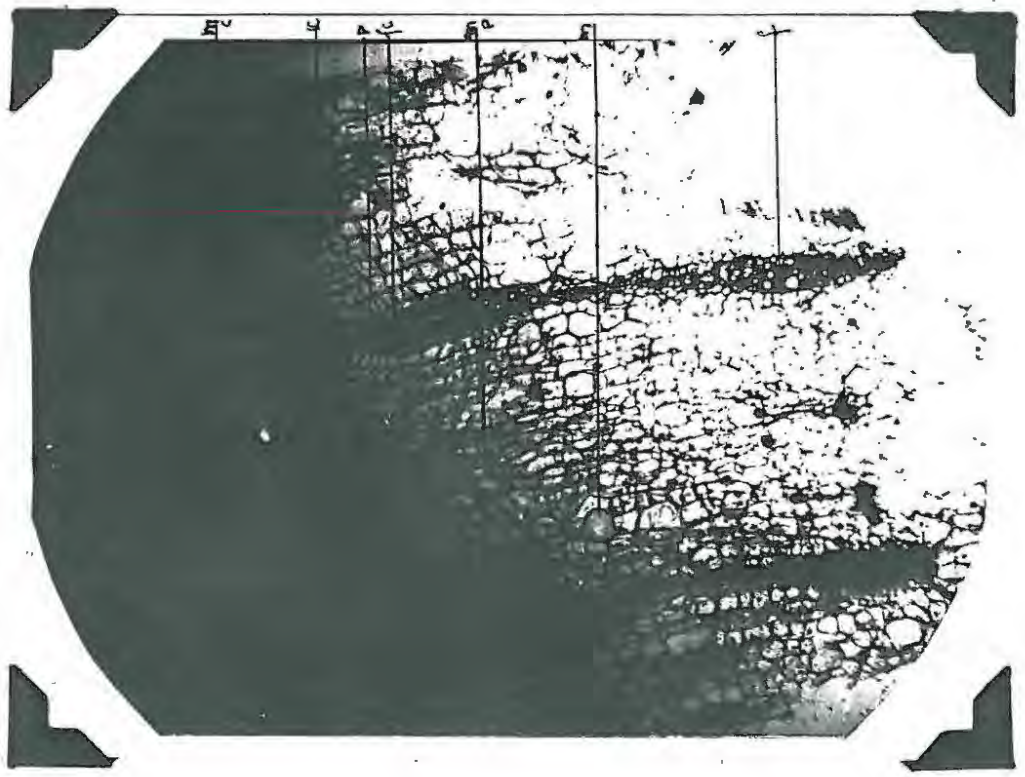


Fig 40.

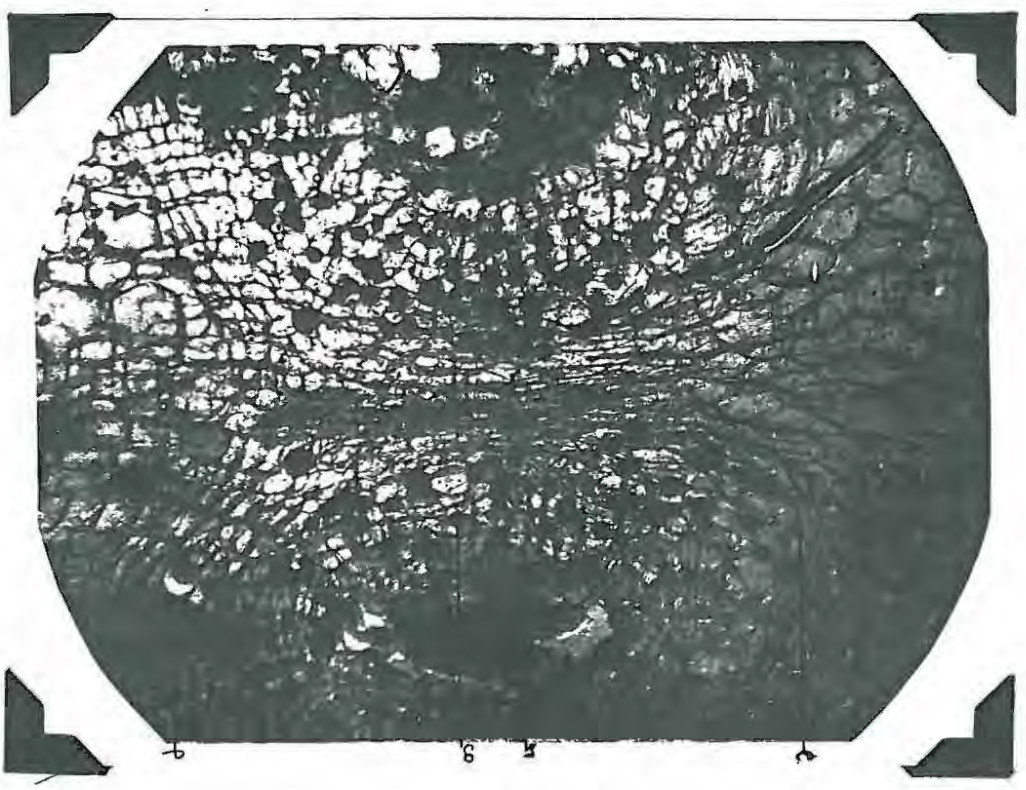


Fig 41.

Fig 42. L.S. vascular bundle of tuber. X150

p. phloem; t spirally thickened trachea of xylem.

Fig 43. L.S. vascular bundle, tuber. X150

tr. tracheids.

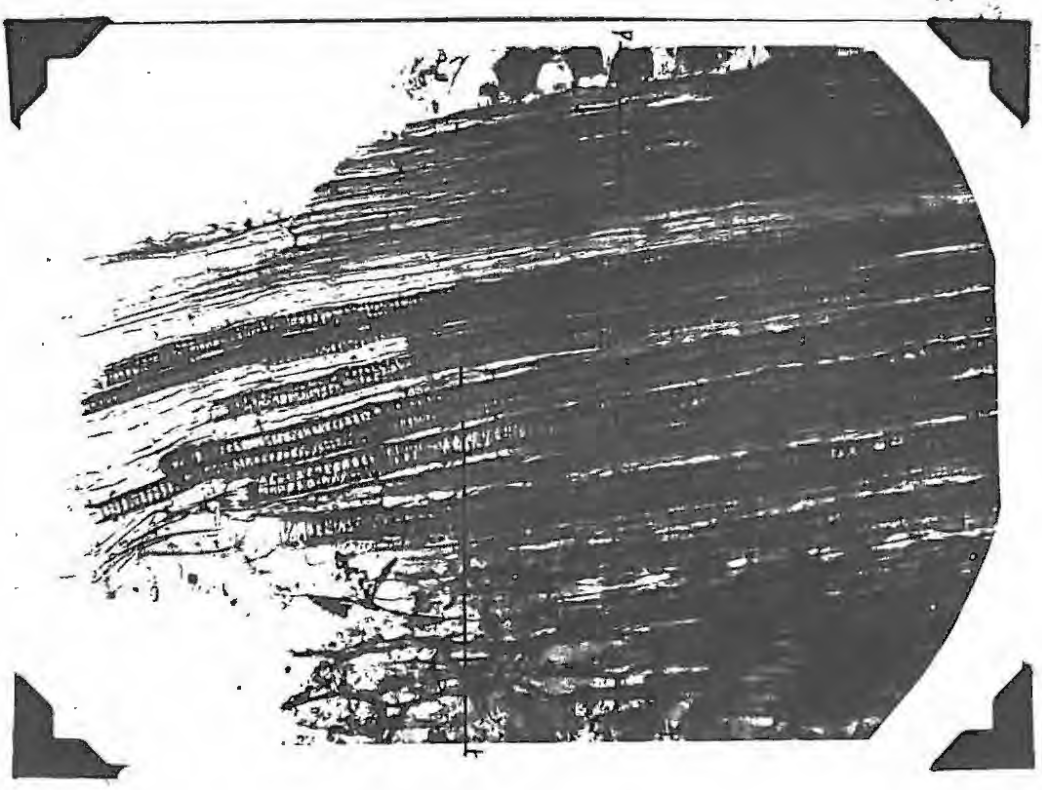


Fig 42.

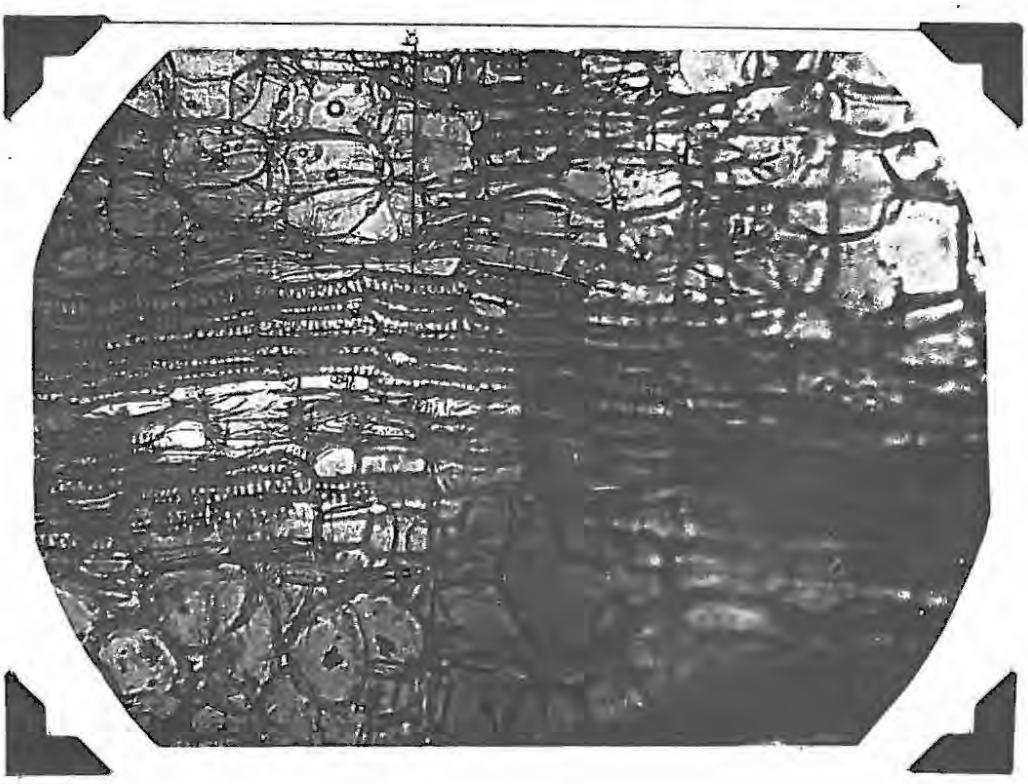


Fig 43.

Fig 44. T.S. tuber; joining up of 3 vascular strands. ×50

mc. large mucilage canal;
co. calcium oxalate crystals;
m. mucilage cell in ray parenchyma
hy. hydrocytes.

Fig 45. T.S. tuber showing hydrocytes at base of vascular bundle. ×150

hy. thick ring of hydrocyte thickning.
s. starch grains surrounding parenchyma.

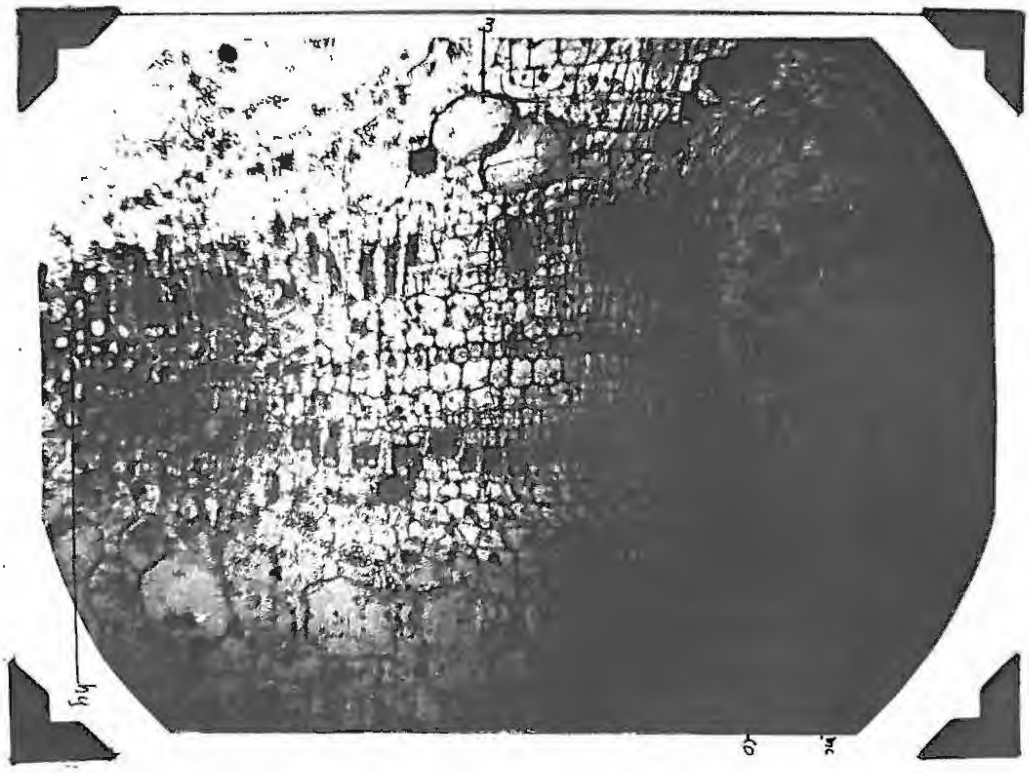


Fig 44.

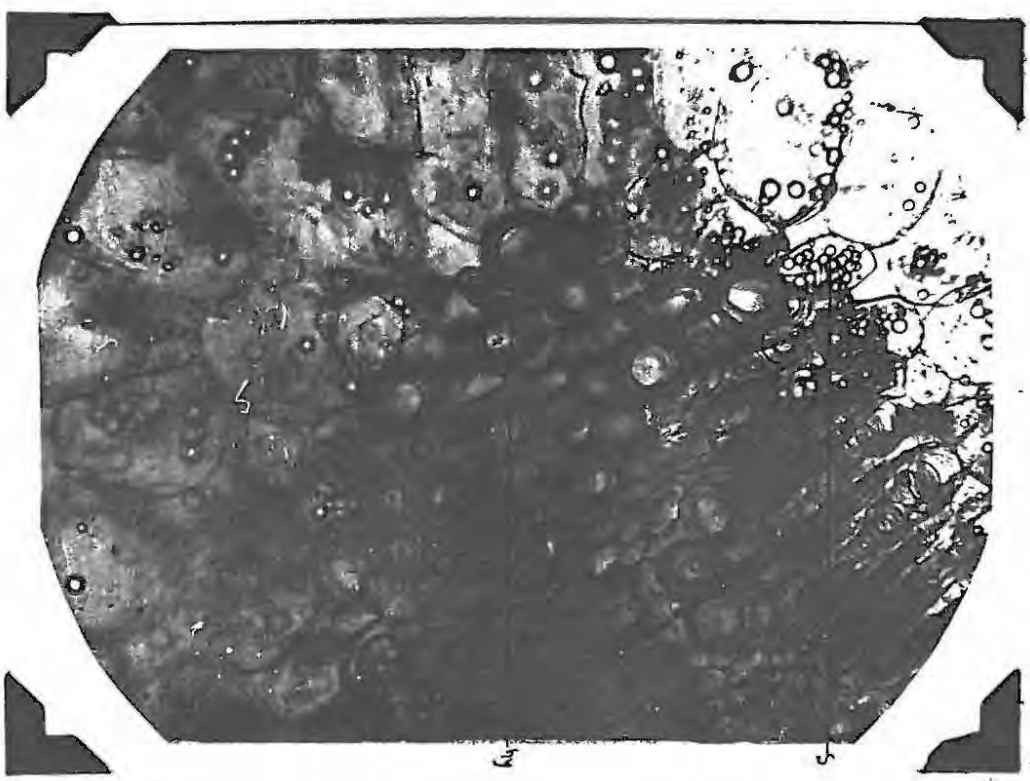


Fig 45.

Fig 46. T.S. vascular bundle of tuber. X50

mc. mucilage canal; co. calcium oxalate crystals; p. phloem; wp. wood parenchyma x. scattered xylem elements; f. fibre patch; mp. medullary ray parenchyma.

Fig 47. Oblique section through end of tuber showing large number of hydrocytes in medullary ray tissue. X50

ub. vascular bundle;
hy. hydrocyte;
s. parenchyma cell containing numerous starch grains.

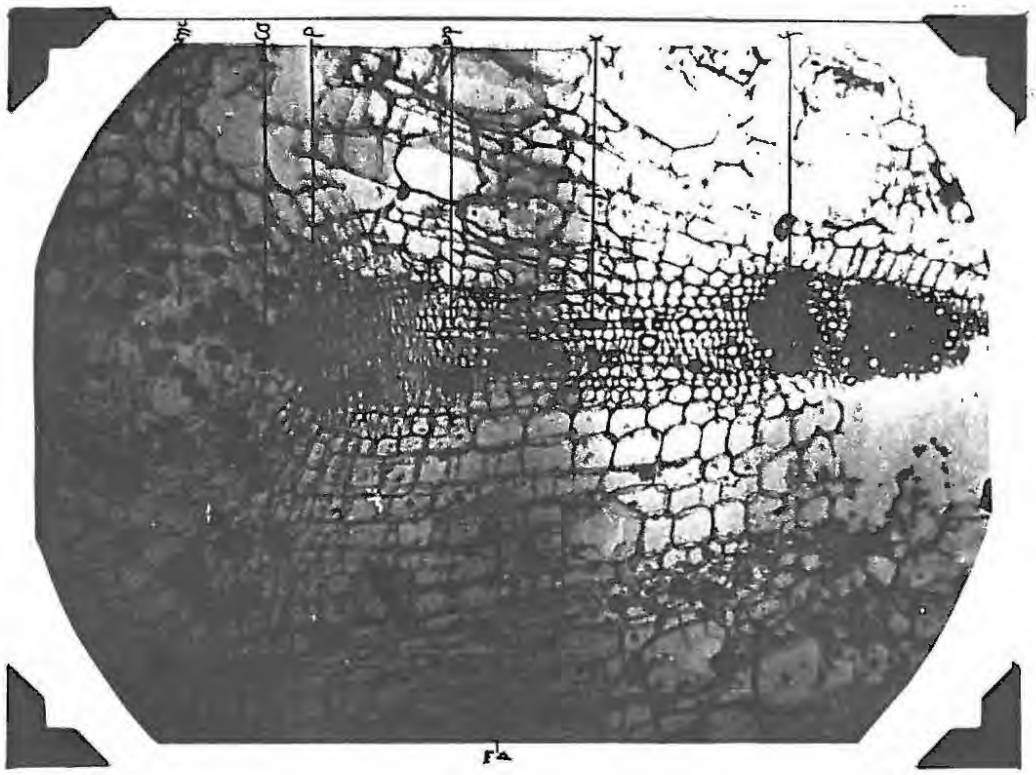


Fig. 46.

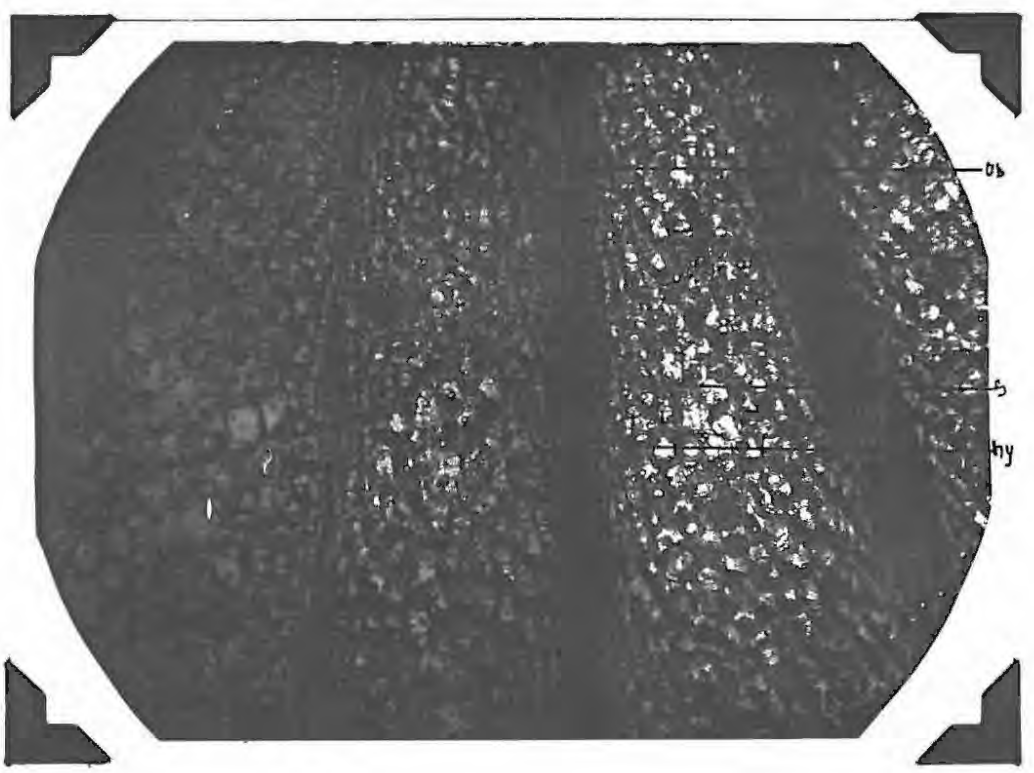


Fig 47.

Fig 48a. L.S. Flower showing stamens fully expanded

Fig 48b. L.S. Flower showing stamens shut after stimulation.

Fig 49a. Stigma and style.

Fig 49 b. T.S. of single stigmatic arm.
p. papilla; v. vascular strand.

Fig 50. L.S. Flower bud.

Fig 50b. Pollen grain.

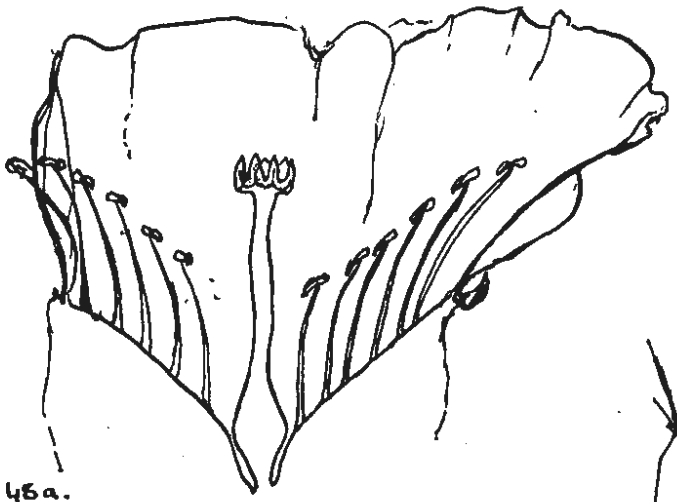


Fig 48a.

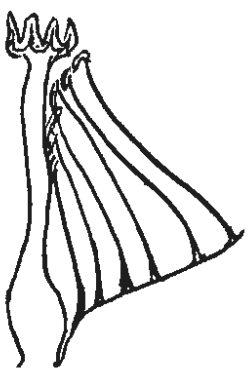


Fig 48b.

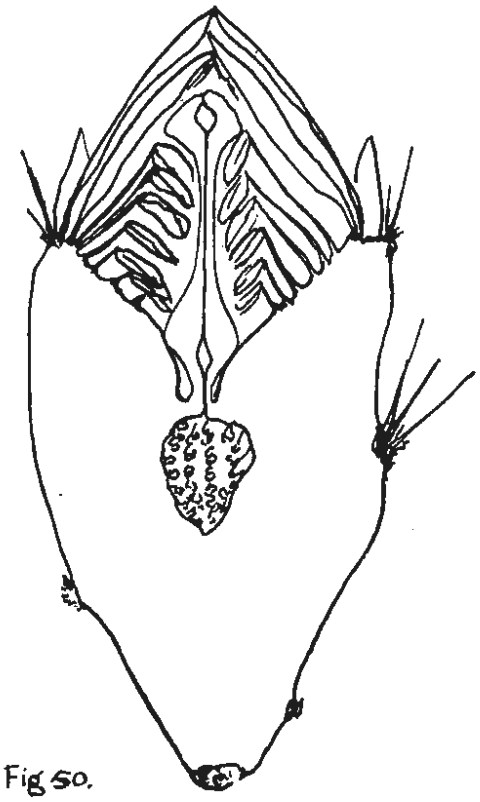


Fig 50.

Fig 49a.

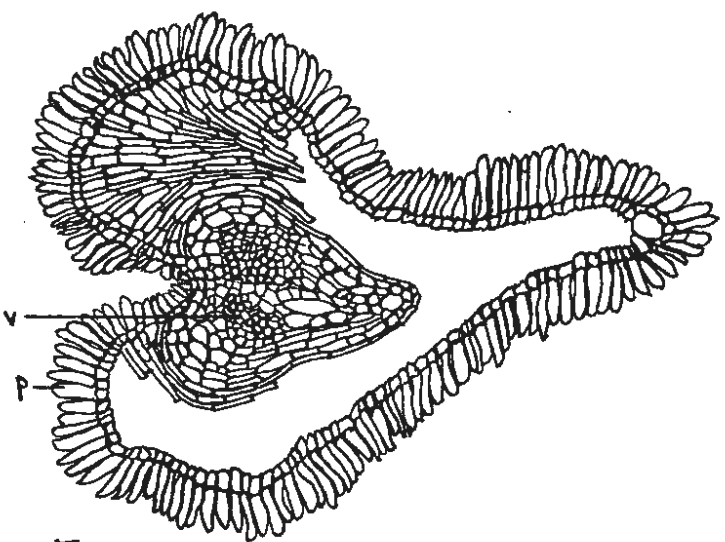


Fig 49b.

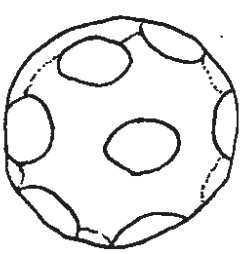


Fig 50b.

Fig 51. L.S. very young flower bud. ×50

gp. growing point; ev. concave top of flower bud; vb. vascular bundle m. mucilage cell; co calcium oxalate crystal.

Fig 52. Growing point of flower bud (ex fig51 enlarged) ×150

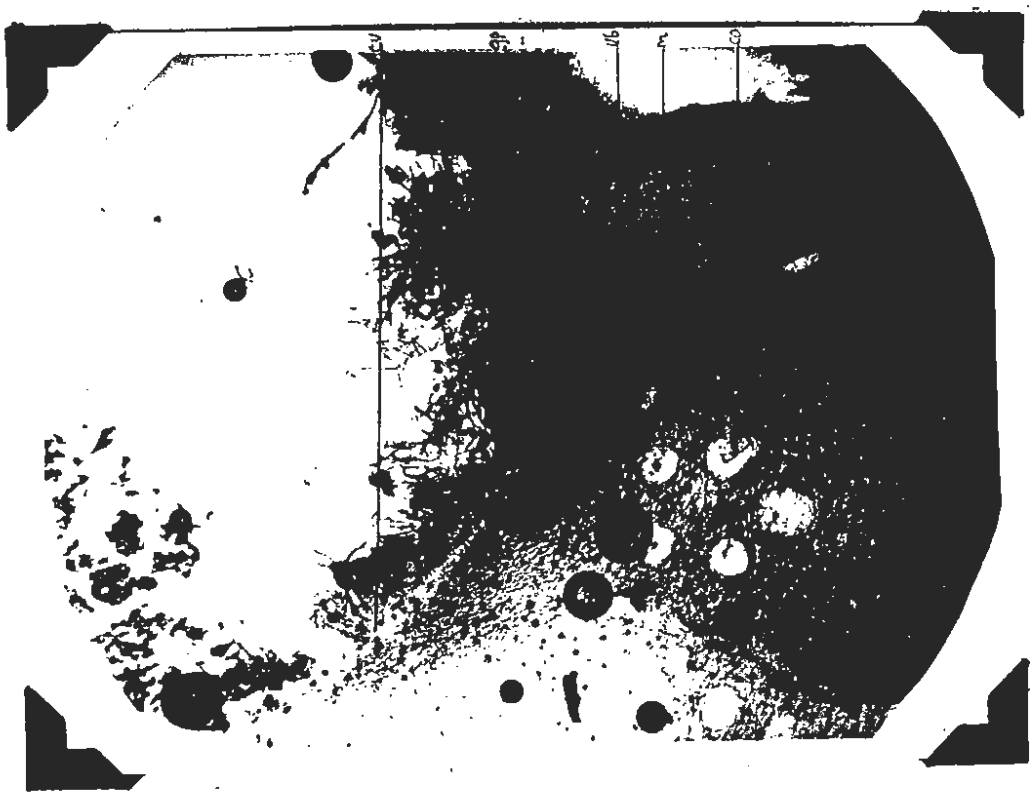


Fig 51.

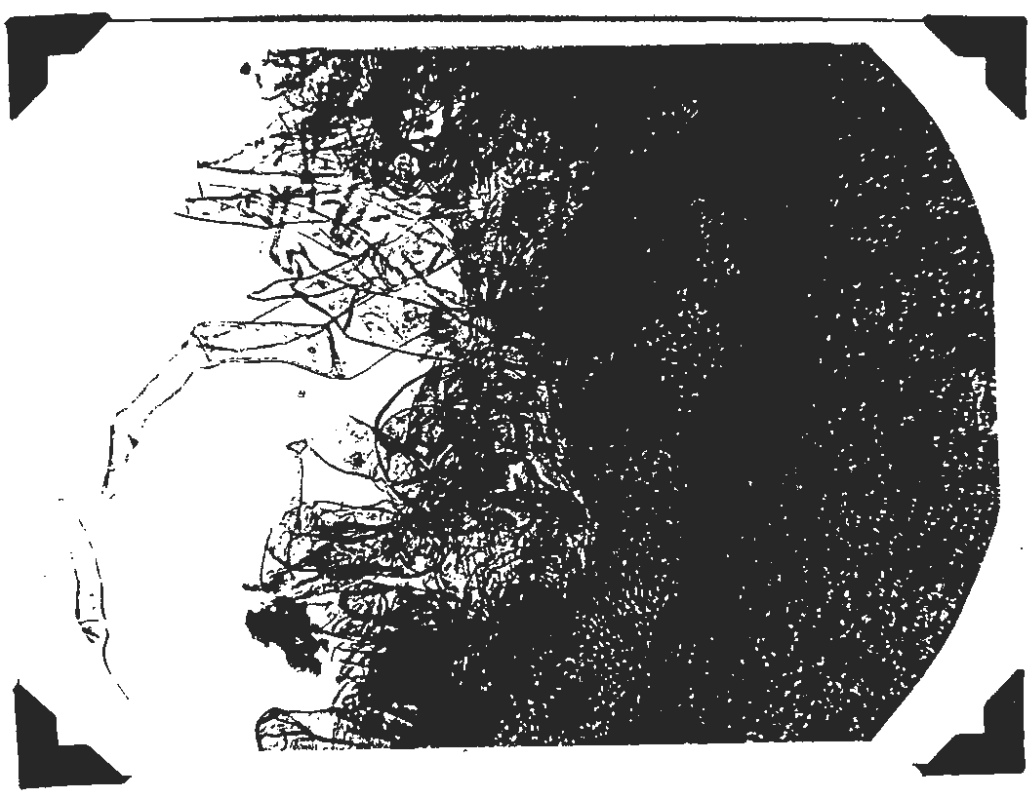


Fig 52.

Fig 53. L.S. young flower bud. X50

vl. vascular bundle of leaf; t. thorn from developing areole on ovary wall; s. sepal; lt. leaf trace; st. stamen initials, c. carpel commencing to grow over to form ovary cavity; dgp. depressed growing point.

Fig 54. Ovule initials on ovary wall. X150
ov. ovary wall.
oc. ovary cavity;
o. ovule initial.

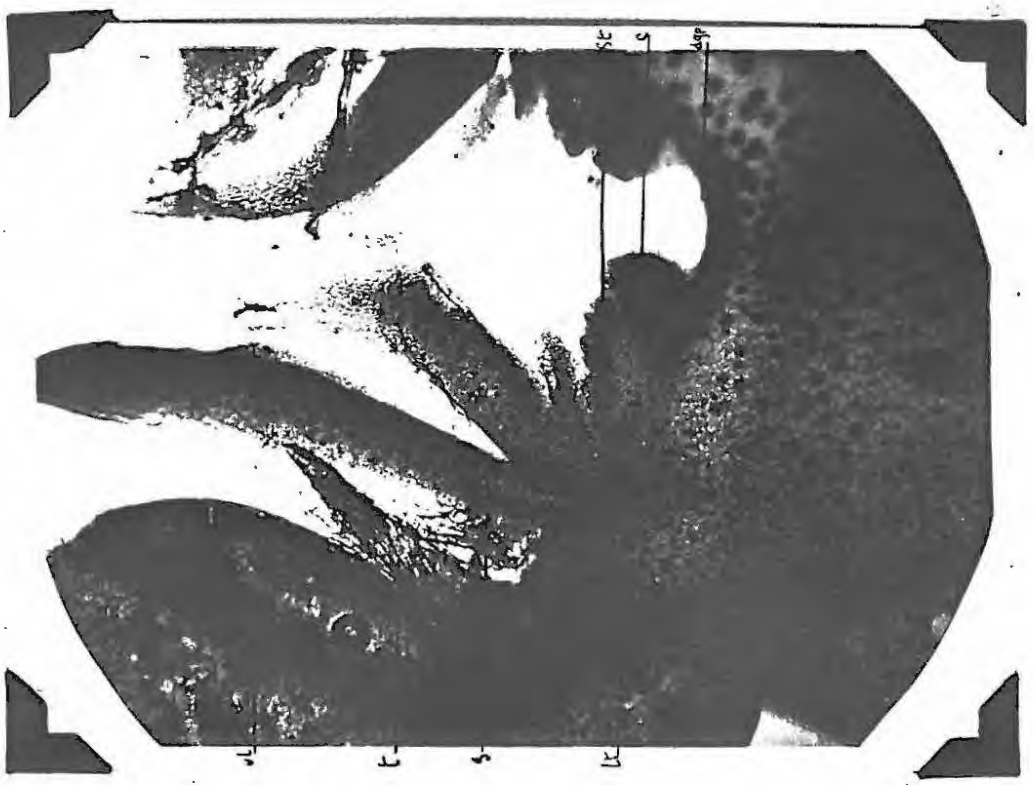


Fig 53.

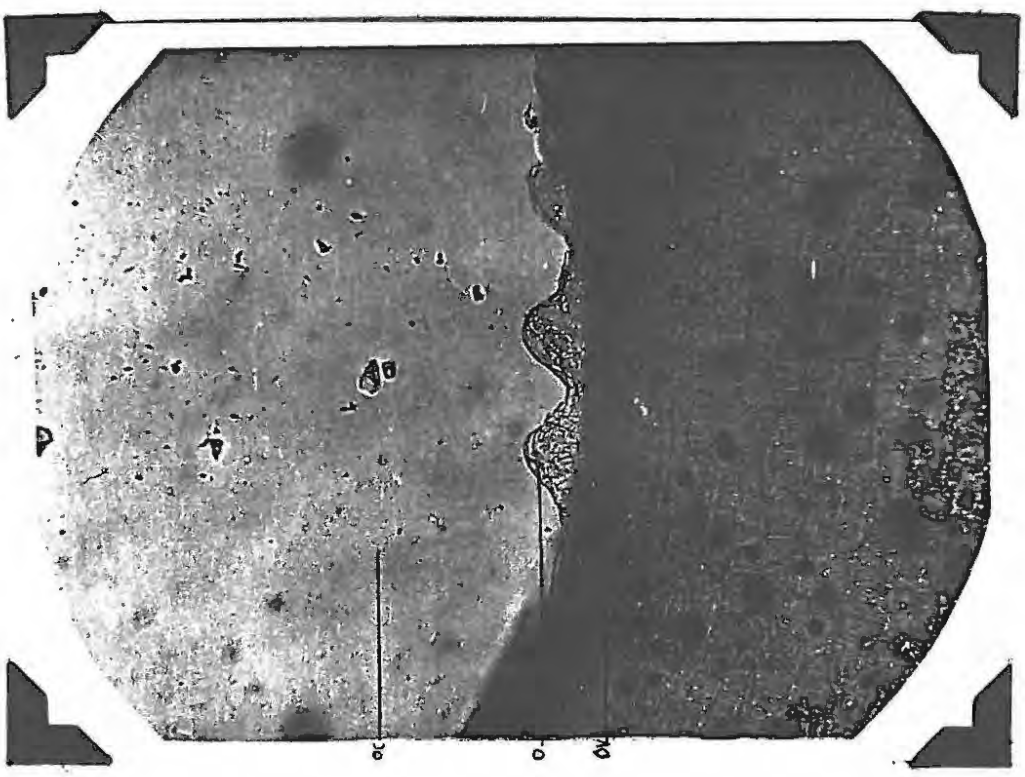


Fig 54.

Fig 55. 2nd stage in development of ovule. X150

fb. base of funicles of two fused.
ov. ovary wall;
oc. ovary cavity.

Fig 56. 3rd stage in development of ovule. X150

f. funicle which has started on its first turn; n. nucellus;
ii. inner integument initials;
oi. outer integument initials.

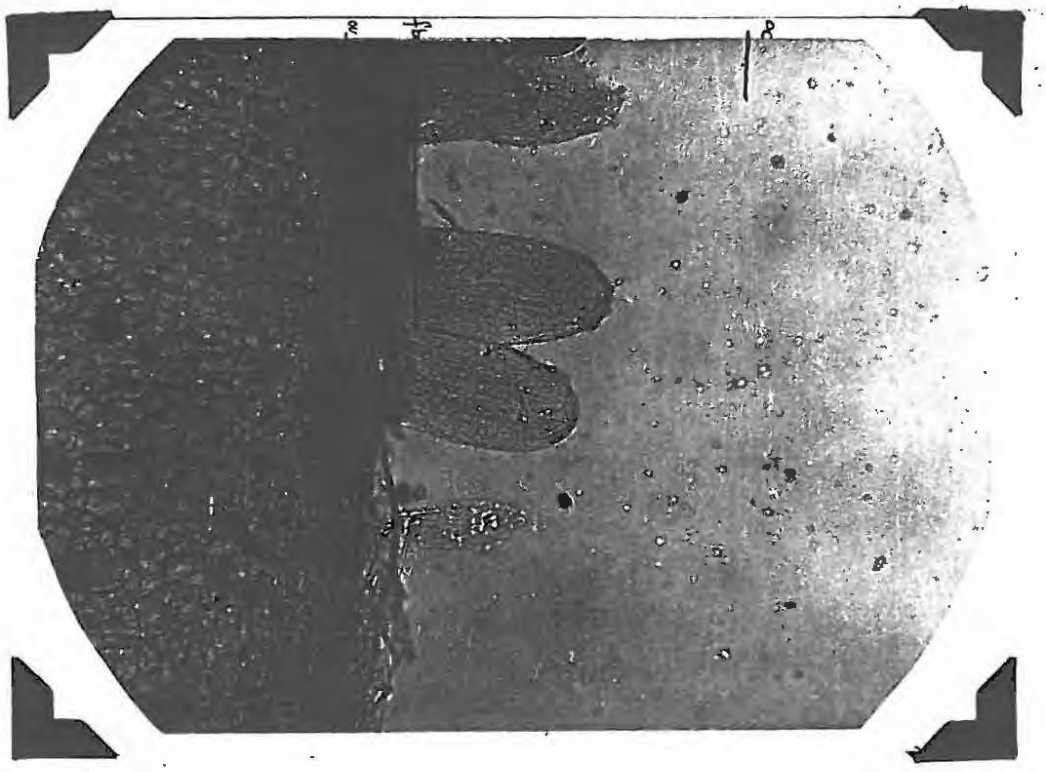


Fig 55.

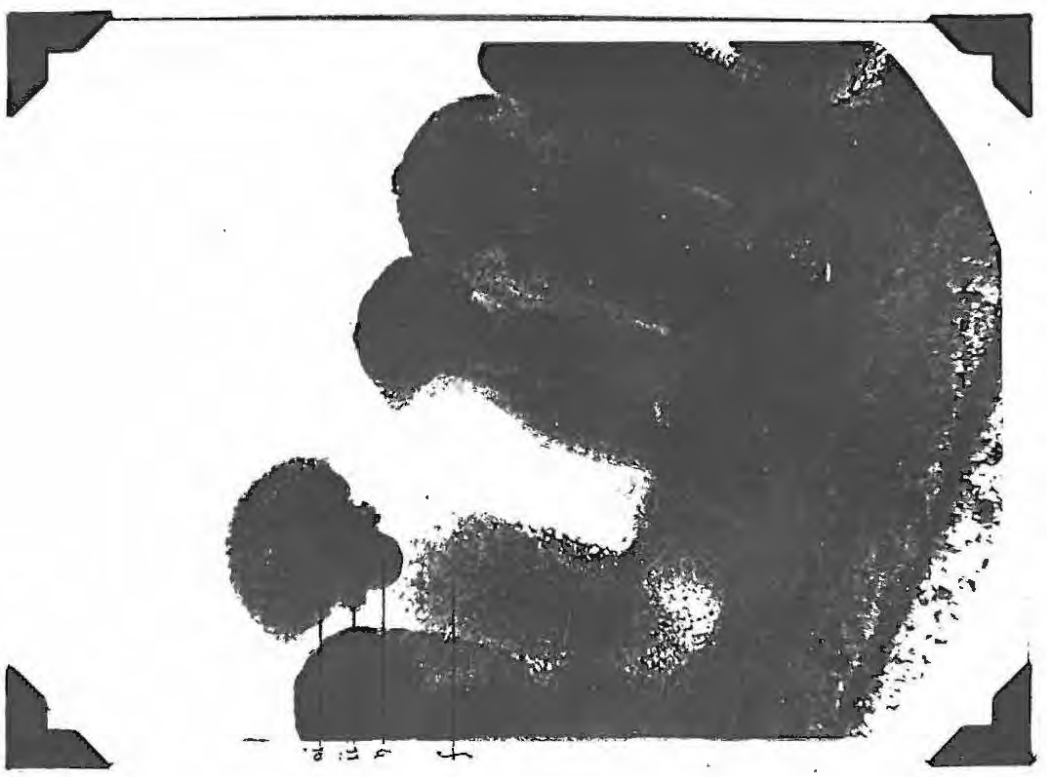


Fig 56.

Fig 57. L.S. of ovule from unopened flower. X 150

f. funicle; pf. papillae innerside of funicle; ov. Ovary wall; oi. outer integument, ii. inner integument; p. papillate cells at top of nucellus. m. micropycle.

Fig 58. ~~same as~~ Fig 57 enlarged. / X 700

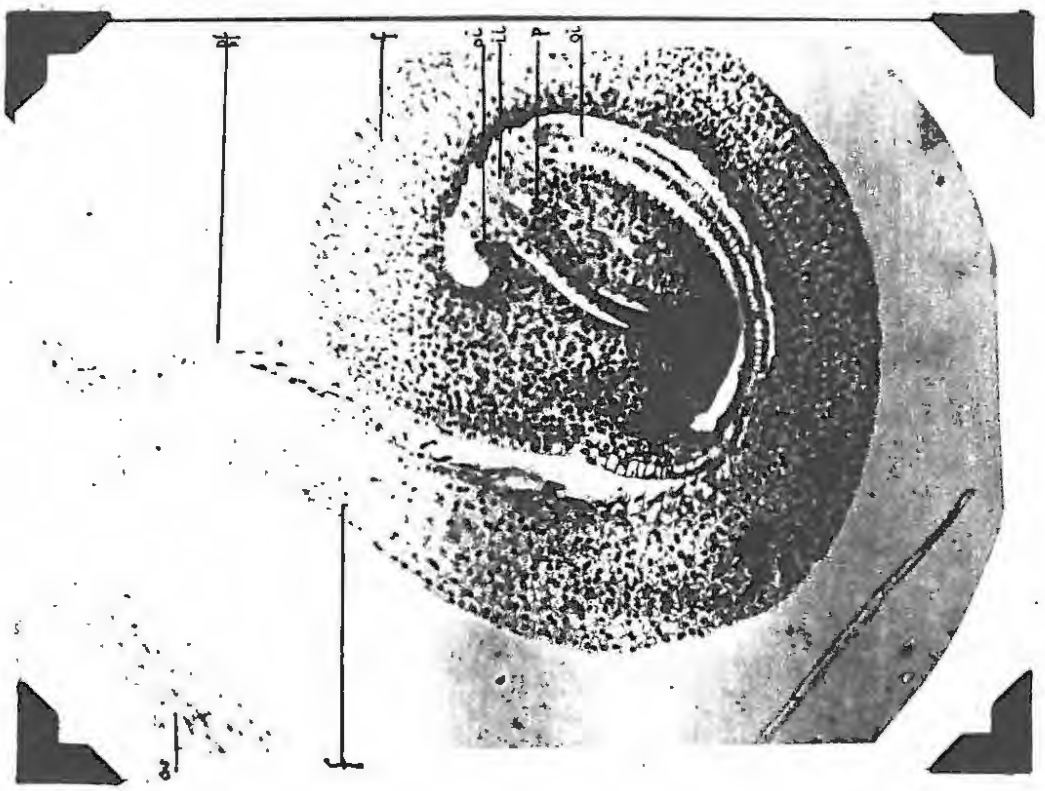


Fig 57.

Fig 56.

Fig 59. L.S. ovule from unopened flower, showing result of first division of megaspore nucleus. ×150

f. funicle; pf. papillae on innerside of funicle; ov. ovary wall; oi. outer layer of outer integument; oi_2. inner layer of same; ii. outer layer of inner integument ii_2. inner layer of same; n. nucellus e. embryosac; tm. swollen top of inner integuiment which alone forms micropyle.

Fig 60. Same as fig 59 enlarged. ×700

m. micropyle; n. nucellus; e. embryosac; en. first two nuclei of first division of megaspore nucleus; ii_1 ii_2 outer and inner layers of inner integument.

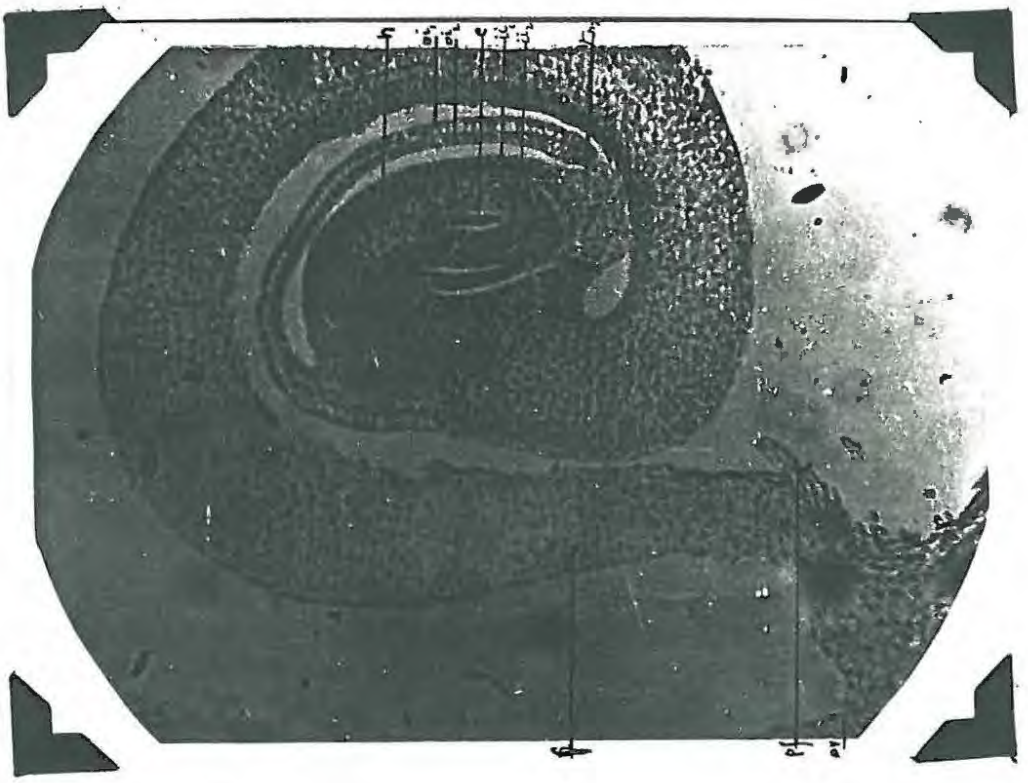


Fig 59.

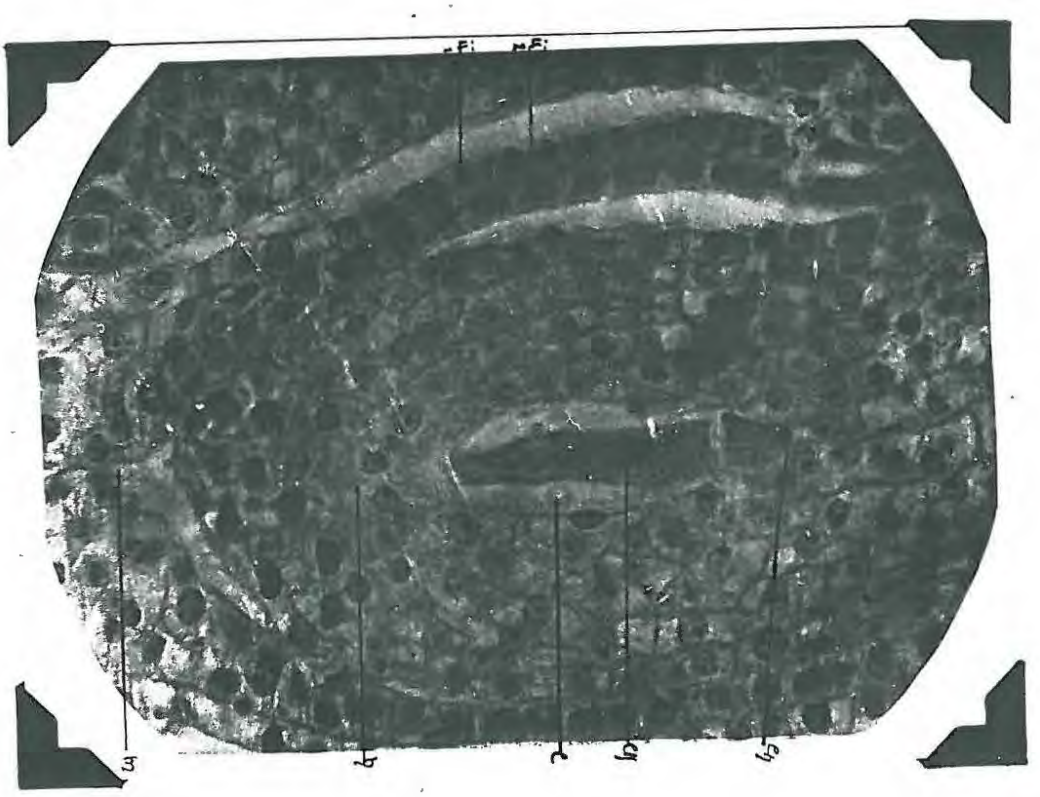


Fig 60.

Fig 61. L.S. ovule from open flower showing probable fertilization. ×150

f. funicle; oi_1 oi_2 outer and inner layer of outer integument;
ii_1 ii_2 outer and inner layers of innerintegument;
m. micropyle region;
e. embryosac with fusing nuclei

Fig 62. Same as fig 61 ~~enlarged~~ showing probably fertilization. ×700

mn. pollen nucleus?
en. egg nucleus?
pn. two polar?
b. starch grains from pollen tube?

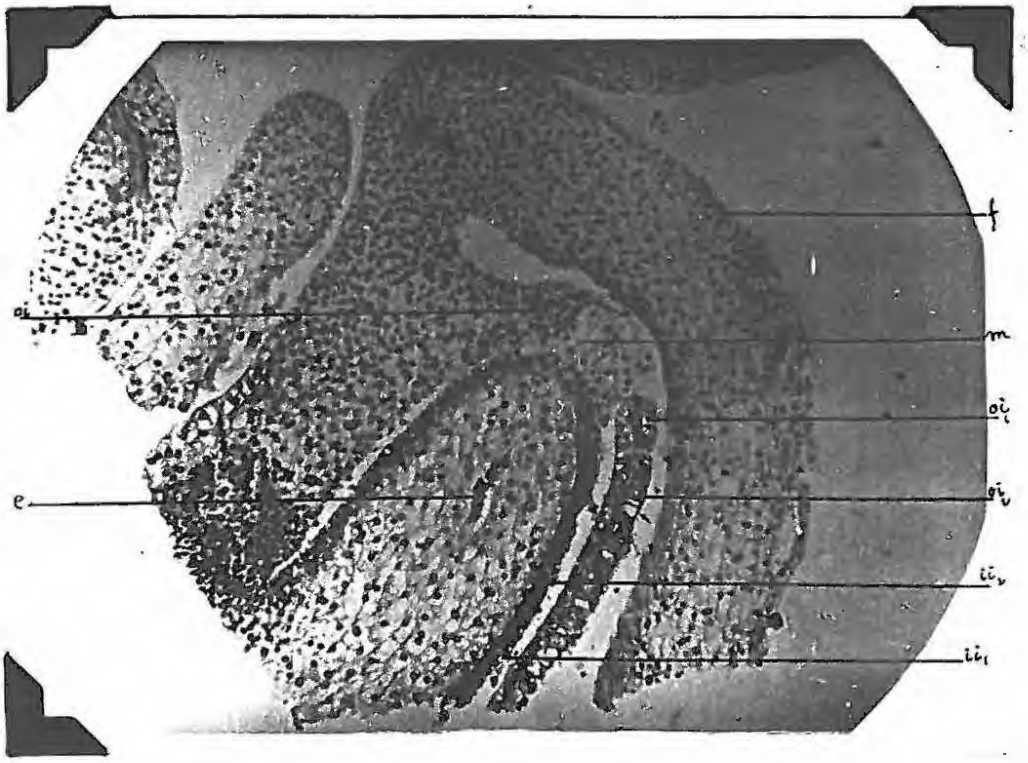


Fig 61.

Fig 62.

Fig 63. L.S. ovule from open flower, top of nucellus. ×700

n. nucellus;
pe. possibly ends of two pollen tubes;
de. remains of disintegrated egg nucleus.

Fig 64. L.S. ovule from very young fruit, showing growth of nucellus. ×150

f. funicle;
oi_1 oi_2 outer and inner layers of outer integument;
bm. cavity below micropyle;
p. possible remains of pollen tubes;
n. nucellus;
e. remains of embryosac being obliterated by increase in nucellus.

Fig 63.

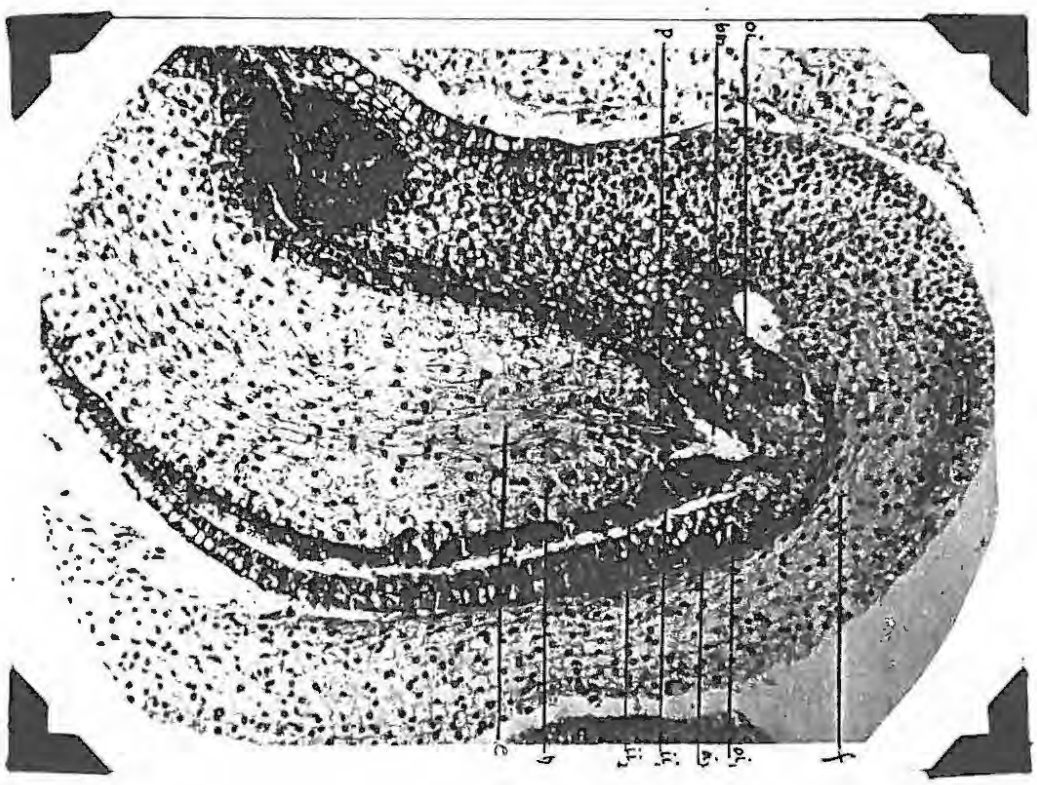


Fig 64.

Fig 65. Diagrams of 3 stages from ovule to embryo

1. Ovule from unopened flower.

2. Ovule from very young fruit.

3. Fully developed embryo of germinable seed (Papillae on outside removed).

ov. ovary wall; f. funicle
vb. vascular supply to ovule;
pp. papillae on outside of funicle.
oi. outer integument;
oi. outer layer of outer integument.
ii. inner integument.
ii. inner layer of inner integument
e . embryosac;
n . nucellus;
p. possible remains of pollen tubes.
r. radicle of embryo;
gp. growing point of embryo;
c. cotyledons.
m. micropyle.

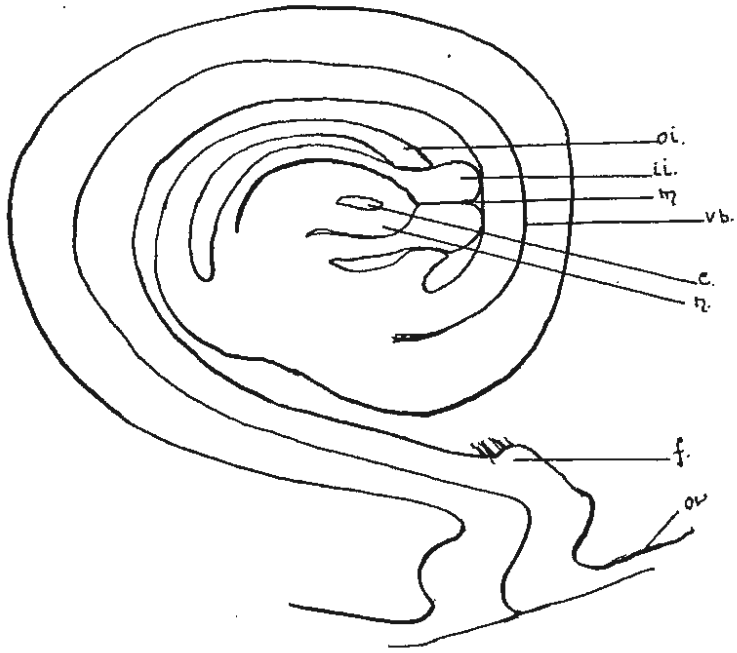
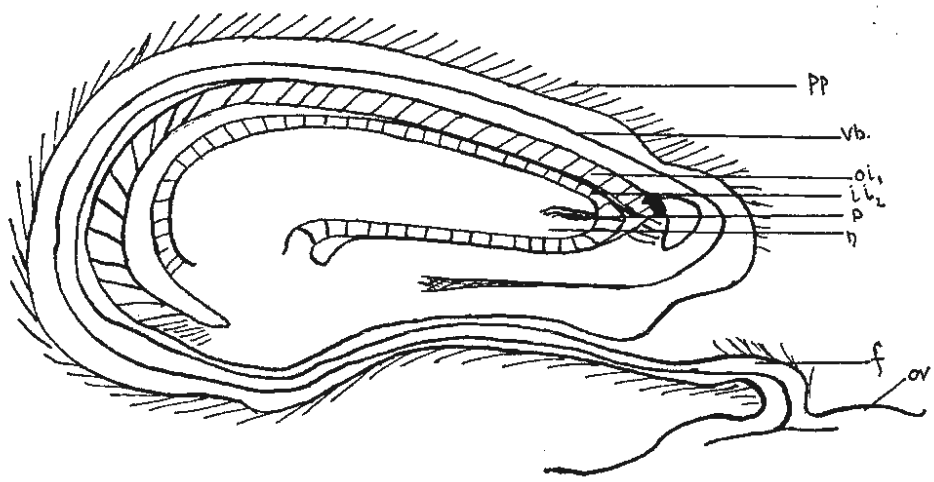
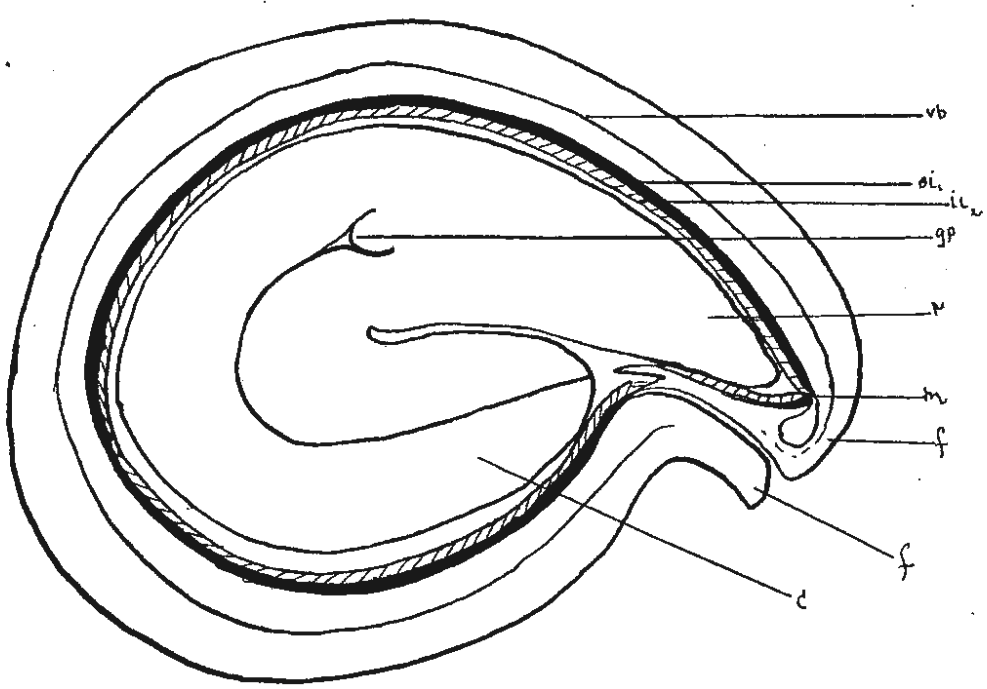


Fig 65.(i).



(ii)



(iii)

Fig 66. L.S. of germinable seed. ×30

f. hard stony funicle;
ii. inner integument.
oi. remains of outer integument.
ub. remains vascular supply to developing ovule.
en. small portion of endosperm;
gp. growing point of
r. radicle
c. cotyledon.
Cells of embryo contain numerous protein grains.

N.B. Top of funicle lost in sectioning.

Fig 67. L.S. of top of funicle enclosing embryo ×50

f. hard stony loop of funicle over micropyle
m. micropyle;
oi. outer integument remains.

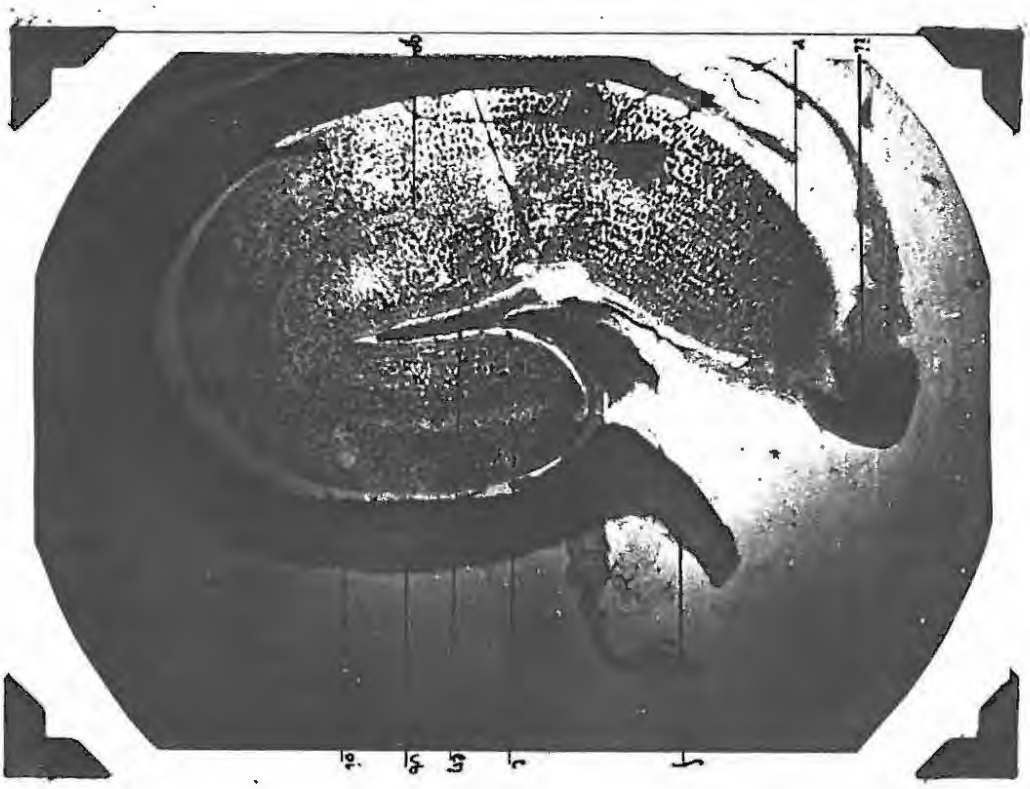


Fig 66.

Fig 67.

Fig 68a. Germinable seed surround by mass of mucilage cells and hairs. X12

Fig 69. Germinable seed with pulpy mass removed. X12

~~Fig 69. Seed with hard seed coat but no embryo.~~

Fig 70 This papery seed. X12

Fig 68.

Fig 69.

Fig 71. Germinating seed after 4 days with two embryos.

c.cotyledon;
h.hypocotyl;
a. adventitious roots from base of hypocotyl;
r. radicle.

Fig 72. Germinating seed with single embryo.

Fig 73. Seed with two seedlings.

rh. root hairs.

Fig 74. Seedling.

j. first joint.
th. thorns;
or. areole.

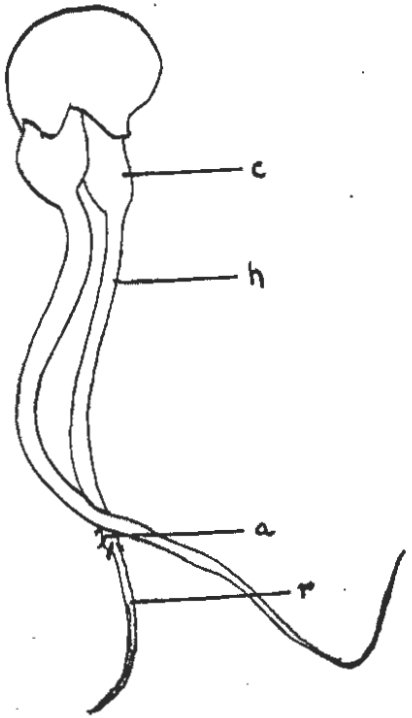


Fig 71.

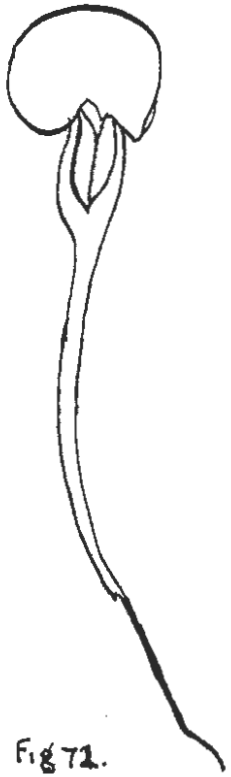


Fig 72.

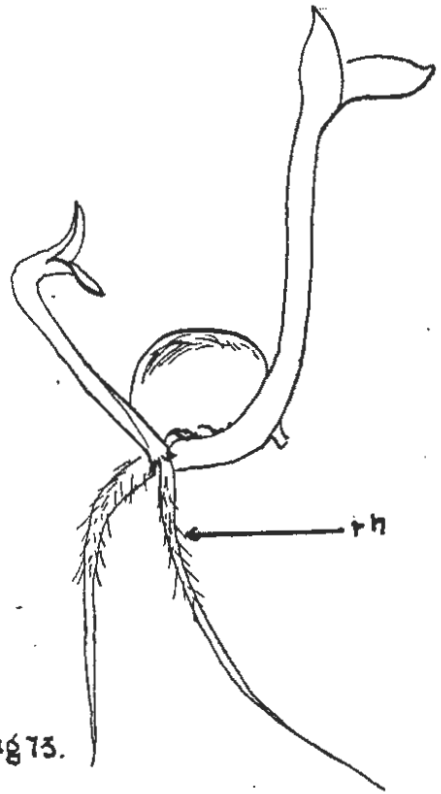


Fig 73.

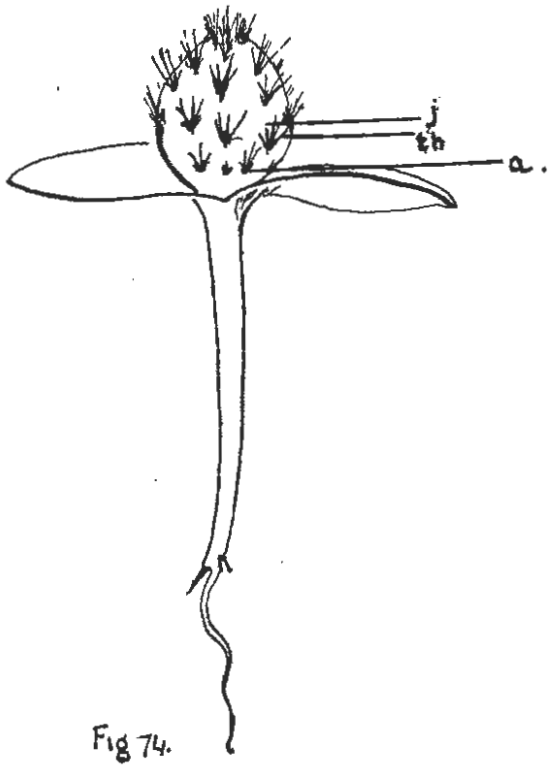


Fig 74.