MORPHOLOGICAL STUDIES IN TERNSTROEMIACEAE.

BY

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Ph. D. 1936.

C O N T E N T S.

GENERAL INTRODUCTION.

This paper consists of descriptions of floral development in certain selected types of Ternstroemiaceae. It is not intended to cover the whole family, the choice of material being determined by the available plants in the Royal Botanic Garden, Edinburgh. The types described are representative of three tribes in the family (3), Saurauja and Stachyurus belong to Sauraujeae, Ternstroemia and Visnea to Ternstroemieae, and Camellia to Gordonieae. The plants of course are in the state of cultivation and the results may therefore be modified by such artificial conditions.

In each case observations were made on the living plant, and, in order to trace out the development of the flower parts, young flower buds of various ages were obtained from the plant. The buds were fixed in Bles Fixing Fluid, and then graded into various sizes, the age of the buds being assumed to be proportional to their size. They were then taken through alcohol into xylol, embedded in paraffin, and sectioned by microtome. Both transverse and longitudinal sections, in complete series, were cut of buds in all the available sizes. The sections were stained by the iron-alum-haematoxylin method, and with the aid of a camera-lucida, outline drawings/

drawings were made of the various stages of development found.

In addition to describing the floral development, an attempt was made to describe and count the chromosomes in each type. The technique adopted consisted in abstracting the anthers from young flower buds at various ages and making smear preparations by crushing in aceto-carmine. The results along this line, however, turned out negative. In two cases only were dividing pollen mother cells found, and even then it was found impossible to count the chromosomes owing to their small size and large numbers.

I. SAURAUJA SUBSPINOSA, ANTH. (I).

INTRODUCTION.

The genus SAURAUJA consists of trees and shrubs found in the tropical and sub-tropical regions of Asia and America. Specimens of SAURAUJA SUBSPINOSA were collected by Forrest during 1924-25 in N.E. Upper Burma, and from seed obtained by this collector, one plant of the species is now under cultivation in the Royal Botanic Garden, Edinburgh. The plant takes the form of a woody shrub, branching freely from near the base, and reaching a height of about ten feet. The leaves are large and lanceolate, having a spiny serrulated margin, and are produced spirally towards the ends of the branches. The inflorescences are produced in the axils of the upper leaves, each inflorescence bearing 15-20 pale rose-pink flowers.

FLORAL DESCRIPTION.

INFLORESCENCE - The inflorescence is axillary, consisting of a peduncle which gives rise to axillary cymes in a racemose manner. Each inflorescence produces 5-7 axillary cymes. Each cyme rises in the axil of a bract and consists of 3-5 flowers. The flowers/

flowers are borne on pedicels, each flower being subtended by a bract and bearing two lateral bracteoles.

RECEPTACLE - Flattened and disc-shaped.

FLOWER - Hermaphrodite and regular, about half an inch in diameter.

CALYX - Five sepals which are strongly imbricated, orbicular, concave and translucent.

COROLLA - Five petals alternating with the sepals. The petals are united at the base to form a gamopetalous corolla, with the free parts of the petals strongly imbricated in the bud. The corolla is pale pink in colour, except in the inside of the cup formed by the fusion of the petals, which is dark red. This gives the flower a very conspicuous appearance.

ANDROECIUM - The stamens are almost invariably 50 in number and adhere to the base of the corolla. When the fused petals are separated it is found that the stamens tend to be arranged in bundles opposite the petals, and a hand dissection of the flower shows that the stamens arise by splitting. The stamens develop centrifugally. The filament is inserted about one third of the way up the anther, which is inclined outwards and dehisces by apical pores.

GYNOECIUM/

GYNOECIUM - The ovary is globose in shape, superior, syncarpous with 5 cells, the cells alternating with the petals. The styles are five in number, fused at the base but free spreading towards the apex. The stigmata are capitate. The ovules, which are anatropous, are numerous in each cell, attached to an exile placenta.

DEVELOPMENT OF THE FLOWER.

CALYX.

The ordinary vegetative leaves of the plant are arranged spirally having a phyllotaxis of $\frac{2}{5}$ and this arrangement is carried into the bracteoles and sepals. The bracteoles and sepals thus arise in a spiral manner, the fourth sepal arising directly above the first bracteole, and the fifth sepal directly above the second bracteole. As in practically all other flowers which are pentamerous and in which two bracteoles are typically present, the sepals arise in a very definite manner (9). The position of the first bracteole is to the left of the median line, and the second bracteole arises slightly higher up, laterally opposed to the first. The first sepal is anterior and to the left of the median line./

line. The second sepal is posterior and distinctly median. The third sepal is again anterior but to the right of the median line. The fourth and fifth sepals are lateral or nearly so, and arise to the left and right respectively of the median line. This appears to be the state of affairs in practically all pentamerous flowers in which two bracteoles are typically present, as opposed to the condition where the bracteoles are absent and the first sepals arise laterally to take the place of the bracteoles. The sepals.... in this flower, being spiral in origin, naturally imbricate in the manner known as quincuncial preflor-ation (6). The manner in which the bracteoles and sepals arise is shown very clearly in Fig.I. This figure shows four transverse sections taken from a complete series, from bud to apex, of a bud which has developed only to the extent of producing its bracteoles and the first three sepals. In Fig.I.D. the position of the fourth sepal is indicated by a small protuberance, which represents in section the first differentiation of the sepal. The production of the sepals in a spiral manner is clearly shown also in Fig.2.A. which is a longitudinal section of a young bud still in the stage of sepal formation.

COROLLA.

There appears to be a distinct space in time between the production of the sepals and the petals, as/

as Fig.2.A. shows a bud with sepals relatively well formed before any indication of petals can be made out. Fig.2.B. shows a longitudinal section in which the first indication of the petals may be seen. In this figure the petals appear to arise from the same level and show no sign of spiral arrangement. The five petals alternate with the sepals and are formed as a true cyclic whorl. This is well seen in Fig.3.A. in which the petals are quite free and discrete in transverse section. The petals fuse at the base at a very early stage, and the bud from which Fig.3.A. was taken was the only one obtained showing the petals free and discrete. The series of sections obtained from this bud gives reasonable evidence of the true cyclic arrangement of the petals, which by their fusion at the base, give rise later to a gamopetalous corolla. As the petals enlarge, the free upper parts become imbricated by sliding growth of their edges as they extend laterally. This imbrication may follow the same arrangement as that invariably found in the sepals, and this is generally found. But this method of imbrication is not invariable in the case of the petals, and the arrangement known as bilateral prefloration (6) is sometimes found.

ANDROECIUM/

ANDROECIUM.

An examination of the mature flower reveals that the stamens, which are numerous, arise centrifugally and show evidence of splitting having taken place. In many cases the complete separation of splitting stamens has not been effected, and one may find as many as three stamens of different sizes all having a common filament at the base. When the petals of the fused corolla are separated carefully and examined, one is able to make out a faint indication of the stamens being arranged in bundles opposite the petals. A single stamen is found opposite each sepal. Another point of interest is that numerous counts revealed that the number of stamens in the flower is almost invariably 50. The stamens arise quite soon after the first indication of the petals as seen in Fig.2.B. which shows the first indication of the stamens as small protuberances, while the petals have not advanced much beyond the same stage. In cutting transverse sections, it was expected that a young enough stage would be found to show ten stamens in two whorls of five. Numerous buds, which, judged by size, would probably be at this stage, were sectioned. The youngest stage found showing stamens, however, had developed to the extent of having fifteen, and Fig. 3.A. represents a drawing of one section in the series/

series obtained from this bud. In this section there are fifteen stamens of which five are definitely placed exactly opposite the sepals, and the others are in pairs, one pair opposite each petal. The stamens opposite the sepals appear to be placed rather further out than the others, and presumably arose first as a whorl of five. It is probable that the other ten stamens may be accounted for, by assuming that they arose by the splitting of five stamens, originally opposite the petals, which formed a whorl further in than the sepal stamens. The fact that the carpels or cells of the ovary are opposite the sepals renders this suggestion all the more probable, as this leads to a regular alternation of 5 sepals, 5 petals, 5 outer stamens, 5 inner stamens, and 5 carpels; the state of affairs in diplostemonous flowers.

The series of sections from which Fig.3.A. was taken are the only ones showing the five sepal stamens in definite position. This definiteness of position of these stamens is lost later, by the rapid multiplication of the stamens and the fusion of the petals. In this way the series of sections obtained from this bud was used to produce evidence of the splitting of the stamens. Fig.4. shows a series of three transverse sections taken from the base to apex of this bud, centred on the region opposite a petal, under high power magnification. This series shows quite clearly/

clearly that the stamens multiply by splitting, and that the splitting takes place from the stamens opposite the petal.

In older buds, both in transverse and longitudinal section, abundant evidence of splitting may be found. The splitting takes place very early in the development of the stamens, as seen in Fig.5.A. which shows indication of splitting in the stamen to the right, while the stamen is still a small undifferentiated protuberance. The facts that the splitting takes place so early in development, that multiplication gives rise to numerous stamens which are closely pressed together in a limited space, and that splitting always gives rise to perfect stamens with four pollen sacs, render it difficult to trace back the origin of the stamens in the older sections. Thus the evidence regarding the origin of the stamens must be looked for in the series of sections from which Fig.4. was taken. An examination of this series failed to reveal any splitting on the part of the stamens opposite the sepals. Such evidence seems to indicate that the stamens are formed originally in two whorls of five, the outer and first formed whorl being opposite the sepals, and the inner, second formed whorl, opposite the petals. Evidence from the same source indicates also that the numerous stamens arise by the splitting of the petal stamens. This/

This may account for the indication of bundles of stamens opposite the petals in the mature flower, and also for the regularity in the number of stamens.

GYNOECIUM.

The ovary arises very soon after the stamens, and the first indication of its differentiation is found in such a young stage as that represented in Fig.2.B. In this section the first indication of the ovary can be recognised as a small depression in the centre of the receptacle, caused by the first rising up of the future ovary wall. The next stage in the development of the ovary is seen in Fig.5.A. As this is a longitudinal section it is impossible to interpret the exact nature of the ovary. However, this section is one taken from a complete series through the bud, and an examination of this series leads one to regard the ovary as taking the form of a small cup. The ovary in transverse section as seen in Fig.3.A. represents the next stage in development, in which the ovary wall forms five protuberances on the inside, which grow inwards to the centre. These protuberances are opposite the petals. It is quite possible that the ovary in a younger stage than represented in Fig.5.A. might arise as five distinct carpellary growths, which fuse very early to form a small cup, and that the ingrowths to the centre, seen in/

in Fig.3.A. represent the lines of fusion of the carpels.

The next stage in the development of the ovary is seen in Fig.3.B. which is one of a series of transverse sections taken through a young flower bud. This series shows that the ingrowths from the inside of the ovary wall meet at the centre and fuse from below upwards. Fig.3.B. reveals also the fact that the placentae are formed very early, being present before fusion takes place at the centre to form the five cells of the ovary. The ovary as seen in a section taken through the apex of this bud is identical with the condition found in the entire interior of the ovary in a younger bud. Fig.5.B. is a drawing showing the ovary in longitudinal section at about the same stage as seen in the transverse section of Fig.3.B. The formation of the placentae before fusion is complete at the centre can again be made out. In a slightly further advanced stage in the development of the ovary fusion at the centre is almost complete and the first differentiation of the styles may be seen. After fusion at the centre is completed to form the five loculi, the ovules are produced on the placentae in each loculus and we thus arrive at the condition found in the mature flower. The styles are formed opposite the sepals and their canals are continuations from the loculi of the ovary which represent the five original carpels.

DEVELOPMENT OF THE INFLORESCENCE.

In the young inflorescence the peduncle is almost erect, and each axillary cyme is enclosed in a green bract. As the inflorescence enlarges, the bracts enclosing the cymes open out to reveal the young flower buds which are also green. The green colour of the inflorescence at this stage indicates photosynthetic activity, which is facilitated by the erect position of the peduncle, allowing greater freedom of light. Each flower is subtended by a green bract and bears two lateral green bracteoles; and later a short pedicel is developed. The bracts subtending the cymes are shed, without withering, just as the sepals of the terminal flower in the cyme part to reveal the pink petals. Up to this point the sepals are green in colour, but they now gradually lose their green colour, turning white and translucent. About 10-14 days after the shedding of the bract subtending the cyme, the terminal flower opens. Then the flower bract and bracteoles quickly wither and fall to the ground; each flower in the inflorescence loses its bract and bracteoles as it opens.

As the flowers are developing the peduncle gradually swings down from its erect position and spreads horizontally. At the same time the pedicels all curve downwards, so that all the flowers after opening/

opening face downwards towards the ground. The stamens come to maturity first, the innermost stamens being ready to discharge their pollen as soon as the flower opens. The pollen is discharged from the anthers by means of apical pores. After the pollen has been shed, the corolla with the adhering stamens falls to the ground in one piece, and does not wither on the plant. The time from the opening of the flower till the corolla is shed is 5-7 days. After the corolla has been shed, the sepals close round the ovary and completely cover it except at the apex, where the five free styles protrude.

Up to this point the stigmata do not appear to be receptive. The flower pedicels now turn slowly round through 180° to become erect, in 3-5 days. It is during this gradual turning of the pedicels that the stigmata become receptive. The stigmata of the flowers, now pointing upwards, show a glistening and mucilaginous surface. If fertilization does not take place, the sepals open out again and wither, the ovary shrivels and turns brown, and with the pedicel falls to the ground. If fertilization does not take place, the sepals remain firmly closed round the ovary.

While the flowers are being pollinated the peduncle of the inflorescence gradually turns upwards to assume an erect position again, with the result that/

that, after pollination of the inflorescence as a whole, the peduncle stands straight up again, carrying the young fruits in an erect position. The sepals remain firmly closed round the young fruit with the five free styles protruding at the top. The return of the peduncle to an erect position places the young fruits in a more favourable position for further development. The movements of the peduncle, and of the flower pedicels, suggest some sort of adaptation for pollination.

POLLINATION.

In the case of the plant concerned, it was observed that a very small number of fruits were formed relative to the amount of flowers produced. This suggests that either the pollination mechanism is not working very efficiently, or that the plant is self-incompatible to a great extent. The flowers have a sweet scent and are very conspicuous in colour. The corolla produces nectar at its base, the nectar-secreting tissue being partly hidden underneath the stamens. In the young flower the sweet scent and presence of nectar will attract insects, which will carry away pollen after visiting the flower. Flowers at this stage, however, do not have receptive stigmata. The stigmata of the flower become/

become receptive, only after the shedding of the corolla and stamens, and the turning upwards of the pedicel. Thus the flower in which the stigmata are receptive does not possess anything which would be likely to attract the insects, and bring about the direct pollination of the stigmata.

When the flower pedicel turns upwards after the shedding of the corolla and stamens, the now receptive stigmata are placed in a very favourable position to receive pollen from the other flowers, higher up, which are still facing downwards, on the same plant or on neighbouring plants. It is probable that the insects, visiting the flowers in search of nectar, will cause the dehiscence of the anthers and the shedding of the pollen, by disturbing the stamens, as the nectar is found at the base of the corolla partly underneath the stamens. In this way the visitation of the insects to the flowers would cause the downfall or spread of pollen. This would bring about the pollination of the receptive stigmata of flowers which are standing erect, lower down on the same plant or on neighbouring plants.

It is more than probable that cross-pollination would be effected in this way, as it would only be in the absence of air currents that the pollen would fall directly down. The dehiscence of the anthers by apical pores, and also the fact that the earliest flowers/

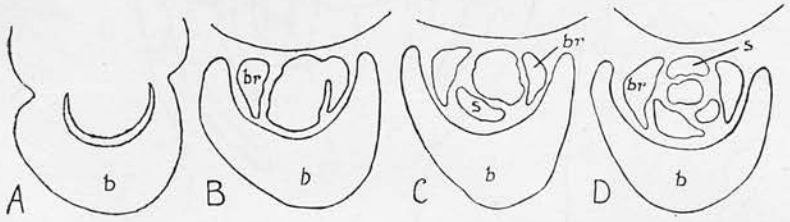


FIG. 1.—A series of four transverse sections taken through a young flower bud still in the stage of sepal formation. × 40.
b = bract, br = bracteole, s = sepal.

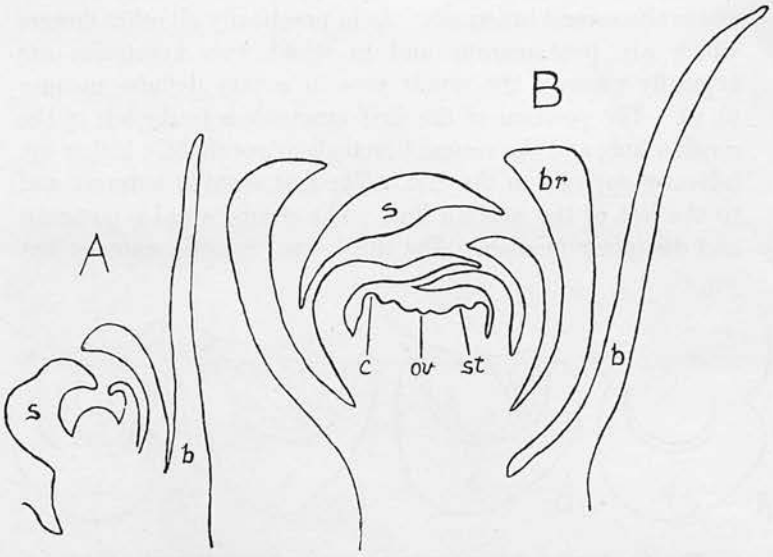


FIG. 2.—Young flower buds in longitudinal section. × 40.
A. Flower bud still in the stage of sepal formation.
B. A further advanced stage showing the first differentiation of petals, stamens, and ovary. This section was not cut through the median plane, and the two bracteoles are seen in section.
b = bract, br = bracteole, s = sepal, c = corolla, st = stamens, ov = ovary.

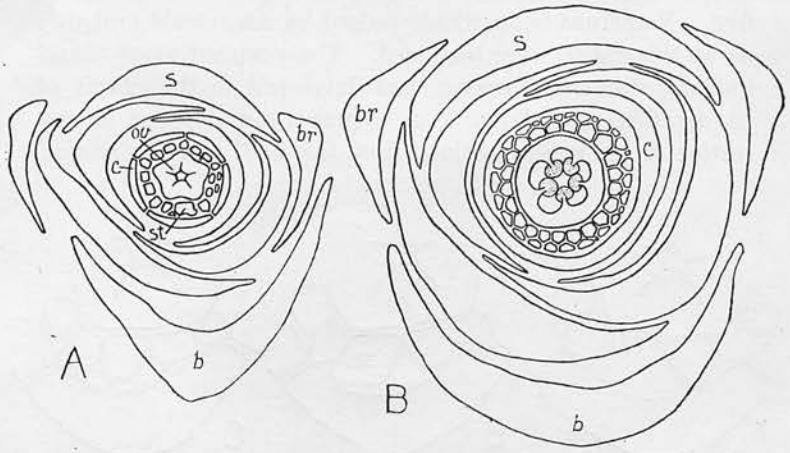


FIG. 3.—Flower buds in transverse section. × 35.
A. Stage showing petals free and discrete.
B. A further advanced stage showing the petals united and the ingrowths of the ovary wall pushing in to meet and fuse at the centre.
Lettering as in fig. 2.

flowers are produced on the lowermost branches, tend to favour this explanation of the pollination mechanism. The low percentage of fruits produced on the plant under observation may be due to the fact that the proper insect is absent, or that the plants are naturally self-incompatible to a great extent.

(For figures of SAURAUJA SUBSPINOSA see enclosed reprint.)

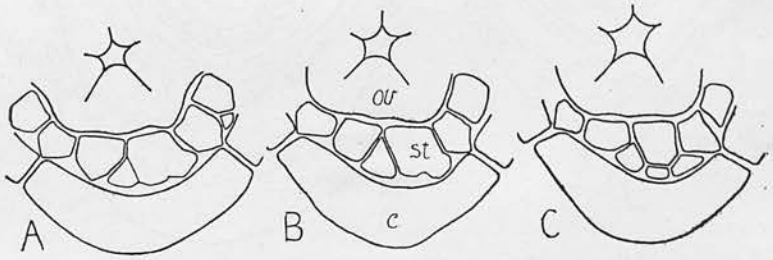


FIG. 4.—A series of three transverse sections, from base to apex, of a young flower bud, centred on the region opposite a petal, to show the splitting of the stamens. × 88. Lettering as in fig. 2.

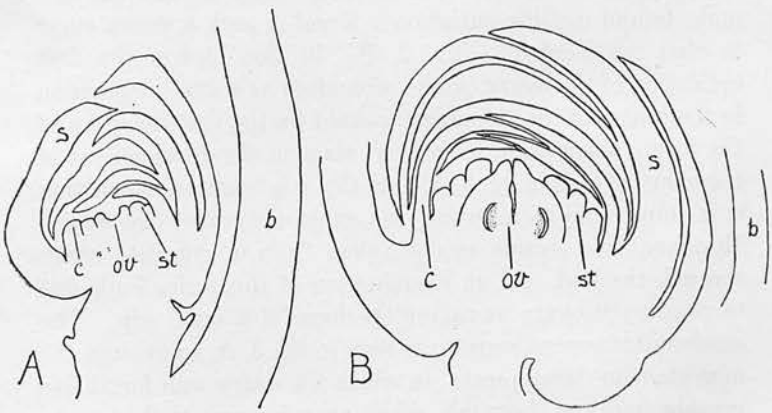


FIG. 5.—Flower buds in longitudinal section. × 32.
A. Early stage in the development of the stamens and ovary.
B. Further advanced stage showing the stamens splitting, and the ovary before complete fusion has taken place at the centre.
Lettering as in fig. 2.

2. STACHYURUS CHINENSIS, FRANCH.

INTRODUCTION.

STACHYURUS is a small genus of shrubs and small trees found in the warmer parts of Eastern Asia. The species under consideration is a deciduous shrub reaching a height of about four feet. The leaves are alternate, oblong-acuminate, serrate and rather membranous. The flowers, which are produced in March and April, are found in axillary racemes, and appear before the leaves.

FLORAL DESCRIPTION.

INFLORESCENCE - The flowers are laterally disposed on axillary racemes. Each flower is carried on a short pedicel and is subtended by a bract and two connate bracteoles. The bract is very small and adnate to the pedicel. The anterior sepal is enlarged and takes the place of the bract in protecting the young flower bud.

RECEPTACLE - Conical.

FLOWER - Hermaphrodite and regular, about half an inch in diameter.

CALYX/

CALYX - Four sepals which are imbricated in the bud, and green in colour.

COROLLA - Four free petals which alternate with the sepals and are also imbricated. The petals are greenish in colour.

ANDROECIUM - The androecium consists of eight stamens in two whorls of four. The anthers are two-celled and dehisce by longitudinal clefts.

GYNOECIUM - The ovary is superior and four-celled. The style is simple with a capitate-peltate stigma. The ovules are numerous, inserted in the inner angle of each cell.

DEVELOPMENT OF THE FLOWER.

CALYX.

In this type the sepals imbricate strongly but their arrangement does not indicate that they are spiral in origin. However, from the arrangement of the sepals in the bud, the manner in which they arise can be traced (Fig.I.). The first sepal is distinctly anterior, and the second arises directly opposite, that is, distinctly posterior. The third and fourth sepals arise to the left and right respectively of the median line. This cannot be regarded as a spiral formation, but it is not a true cyclic whorl, as the sepals arise from successively higher levels on/

on the receptacle (Fig.2.).

COROLLA.

The petals arise alternating with the sepals and are quite free; no sign of fusion can be traced. They appear to be cyclic in origin but they imbricate strongly in the manner known as left convolute prefloration (6). In this prefloration, each petal, in relation to the two petals adjoining it, is partly inside and partly outside (Fig.I.). This type of prefloration is quite general in types where the petals are symmetrical in arrangement and sliding growth takes place as the petals extend laterally.

ANDROECIUM.

The stamens are eight in number and no indication of increasing by splitting can be traced. They arise in two whorls of four. The first four arise opposite the sepals, and the second whorl, alternating with the first, arise opposite the petals (Fig.I.), and are placed slightly further in.

GYNOECIUM.

The gynoecium appears first as four separate carpels which arise opposite the sepals. The carpels are quite free from each other in the younger stages (Figs. 1. and 2.), except at the base where fusion takes/

takes place very early in development. The edges of the carpels are slightly curved inwards. As development proceeds the carpels meet and fuse at their edges to form the ovary wall. This fusion takes place at the base and gradually extends upwards. Then the fused edges of the carpels grow in towards the centre of the ovary (Fig.3.), where they meet and fuse from below upwards, to divide the ovary into four cells. After fusing at the centre to form the central column of the ovary, the edges of the carpels then turn slightly into each cavity to form the placentae.

EXPLANATION OF FIGURES.

Fig.1. - Transverse section of a young flower bud. X 80. b - bract, br - bracteole, s - sepal, c - corolla, st - stamen, ov - ovary.

Fig.2. - Longitudinal section of a young flower bud. X 80. Lettering as in Fig.1.

Fig.3. - Transverse section of a further advanced flower bud. X 80. Lettering as in Fig.1.

Fig.4. - Longitudinal section of a further advanced flower bud. X 80. Lettering as in Fig.1.

STACHYURUS CHINENSIS.

FIG. 1.

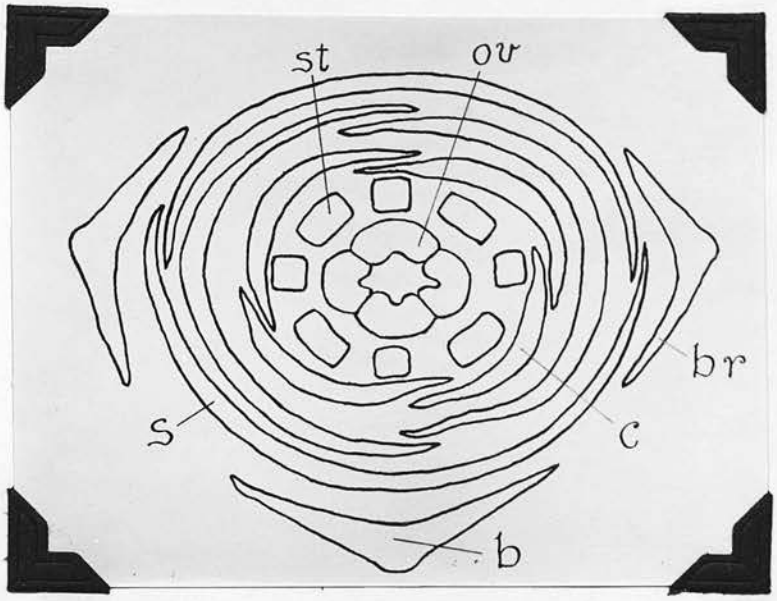


FIG. 2.

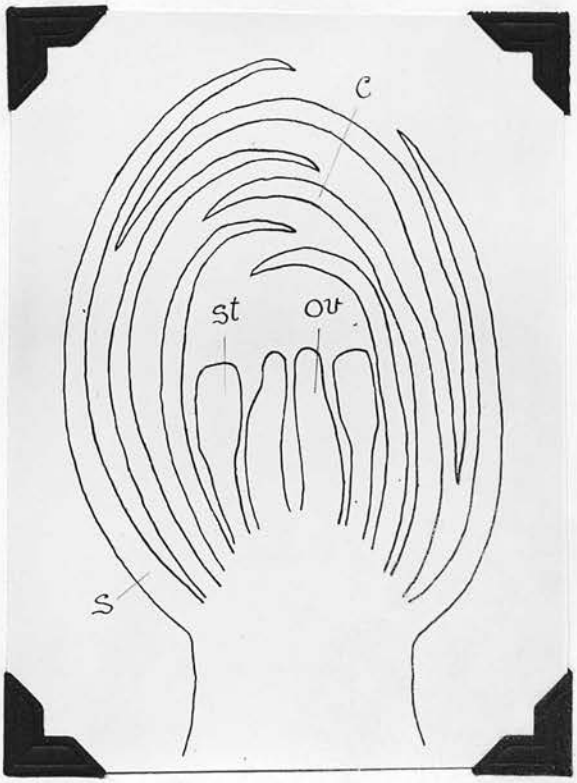


Fig. 3.

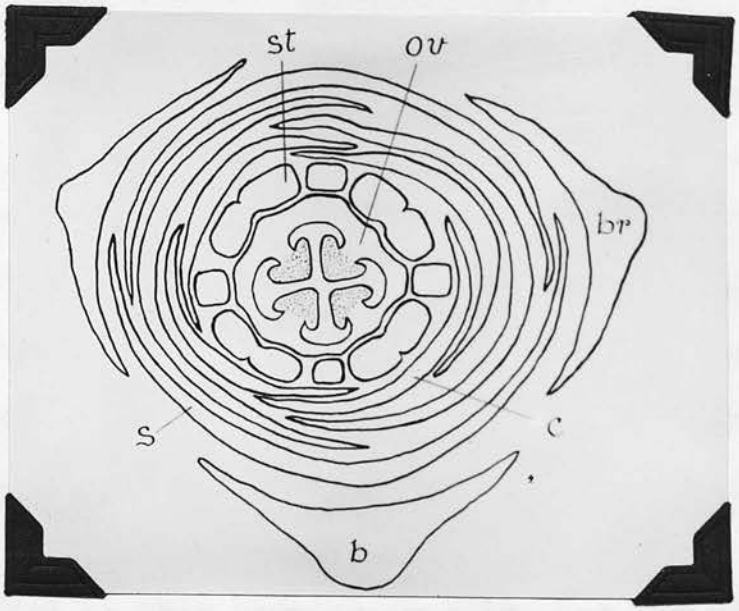
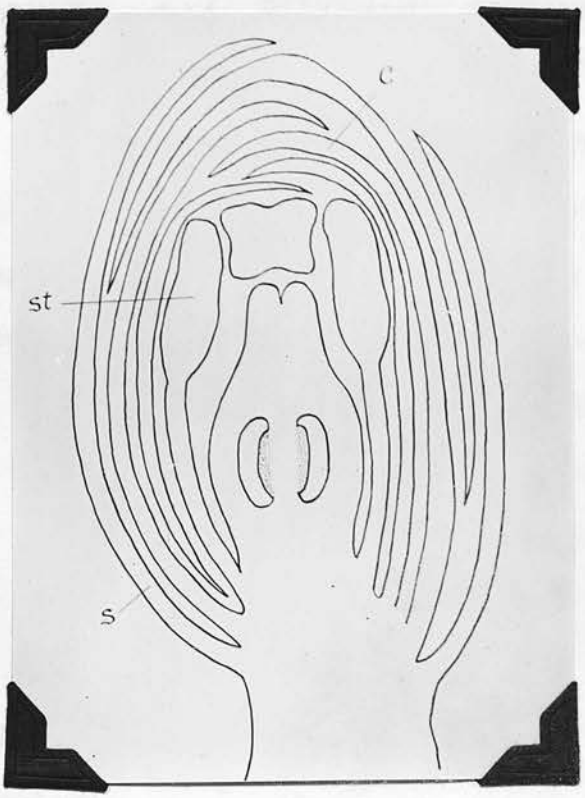


Fig. 4.



3. CAMELLIA CUSPIDATA. COHEN STUART.

INTRODUCTION.

The genus CAMELLIA consists of trees and shrubs found in tropical Eastern Asia and the Indian Archipelago.

CAMELLIA CUSPIDATA is a cultivated plant in this country introduced from China. It was discovered in the neighbourhood of Ichang by Augustine Henry in 1886, and was among the first plants collected by E.H. Wilson in the same district in 1900. The plant flowered in this country in 1912, and has since been in cultivation, being regarded as one of the hardiest of the Camellias. At Kew it does well in the open and flowers freely from March onwards, but at the Royal Botanic Garden, Edinburgh, it is under glass and flowers during December and January.

The plant is an evergreen shrub from 3-12 feet high, with slender branches, almost entirely glabrous in all parts. The leaves are stalked, lanceolate to oblong or elliptic, long and narrowly acuminate, leathery dark dull green, with nerves and veins obscure. The flowers are axillary.

FLORAL DESCRIPTION.

INFLORESCENCE - The flowers are solitary or in

clusters/

clusters of two or three in the leaf axils at the ends of the branches, and are sub-sessile. The very short pedicels are covered by a succession of small imbricate ovate persistent bracts.

RECEPTACLE - Conical.

FLOWER - Hermaphrodite and regular, about one inch in diameter.

CALYX - Five sepals which are strongly imbricated. The sepals are ovate - rotundate, long, green and firm.

COROLLA - The number of petals varies from five to seven. They are strongly imbricated and white in colour.

ANDROECIUM - The androecium is formed of an indefinite number of stamens, the filaments adhering to the base of the corolla, and united among themselves for a short variable distance below. The most interior are almost entirely free. The anthers, first extrorse, then versatile, have a thick connective bearing on the edge of two narrow cells, each dehiscing by a longitudinal cleft, and are bright orange in colour.

GYNOECIUM - The ovary is superior, with three cells, surmounted/

surmounted by a hollow style. The style is divided near the apex into three tubular branches, each bearing a stigmatiferous surface. In the internal /of each cell there ? angle is a placenta supporting one to three anatropous ovules.

DEVELOPMENT OF THE FLOWER.

CALYX.

The flower is subtended by a succession of small bracts which vary in number and arise in a spiral manner, imbricating strongly. The sepals also arise in a spiral formation, imbricating in quincuncial prefloration (Fig.1.), in the same way as the calyx of SAURAUJA SUBSPINOSA. The first sepal to arise is anterior to the left of the median line. The second sepal is distinctly posterior. The third is anterior to the right of the median line. The fourth and fifth are lateral to the left and right respectively of the median line.

COROLLA.

The number of petals varies from five to seven, the usual number being six. They are quite free and spiral in origin. They imbricate strongly but the manner in which they imbricate varies, and does not always/

always follow the spiral formed by the calyx (Fig.1.). The first three petals to arise seem to be very constant in position but the others vary in different flowers. The first is distinctly anterior. The second is posterior to the left and the third lateral to the right of the median line. The variation in the number of petals and in the order in which they arise is due to the fact that the plant is under cultivation, and shows a tendency to increase the number of petals.

ANDROECIUM.

The fully developed flower shows an indefinite number of stamens which are cyclic and arise centrifugally by splitting. Many of the stamens do not completely split apart and are joined together at their base. This is particularly so with the most exterior stamens. In the youngest buds sectioned the stamens varied in number from ten to twenty (Fig.1.), and in older sections, splitting of the stamens could easily be made out. The evidence from the sections suggests that the stamens are originally ten in number, in two whorls of five, opposite the sepals and petals. As development proceeds, numerous stamens are formed by continuous splitting of all the original stamens.

GYNOECIUM./

GYNOECIUM.

In its earliest development the ovary originates as three separate carpellary growths, which arise opposite the first sepals (Fig.1.). As development proceeds the three carpels meet at their edges and fuse from below upwards, to form the ovary wall. While this fusion is gradually going on up the length of the ovary, three protuberances are formed, on the inside of the ovary wall at the points of fusion of the original carpels, which grow inwards to the centre (Fig.3.). The three ingrowths meet and fuse at the centre to form a central column, dividing the ovary into three loculi. In the internal angle of each loculus the fused carpels turn slightly into the cavity to form the placentae, upon which the ovules are later produced.

EXPLANATION OF FIGURES.

Fig.1. Transverse section of a young flower bud. X 80. b - bract, br - bracteole - s - sepal, c - corolla, st - stamens, ov - ovary.

Fig.2. Longitudinal section of a young flower bud. X 80. Lettering as in Fig.1.

Fig.3. Transverse section of a further advanced flower bud. X 80.

Lettering/

Lettering as in Fig.1.

Fig.4. Longitudinal section of a further advanced flower bud. X 80.

Lettering as in Fig.1.

CAMELLIA CUSPIDATA.

FIG. 1.

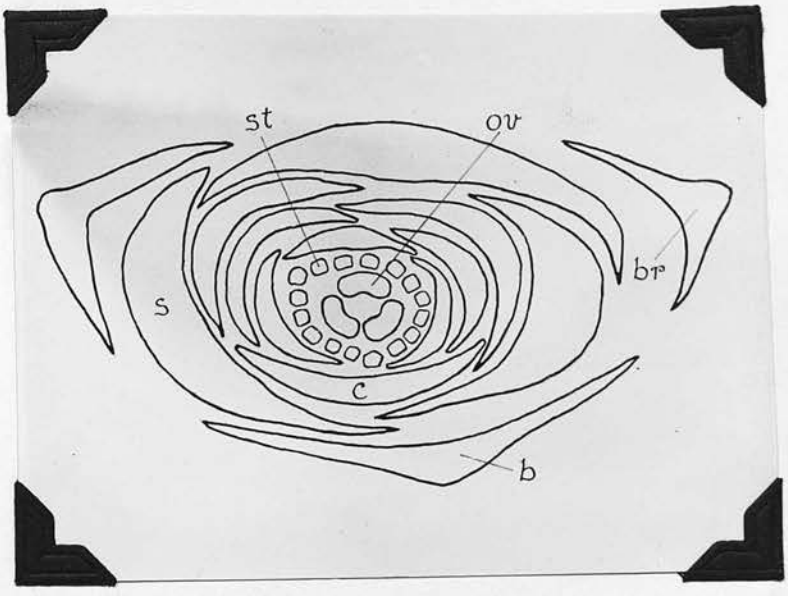


FIG. 2.

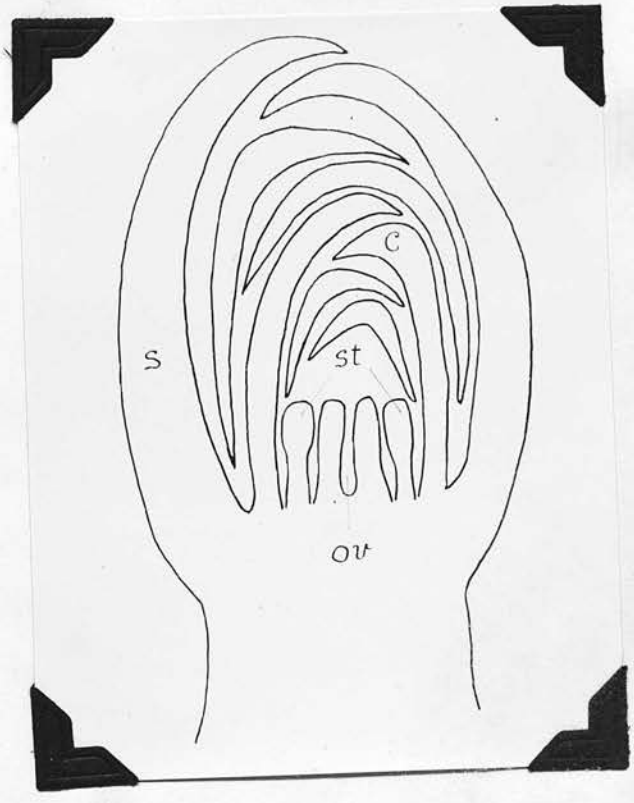


Fig. 3.

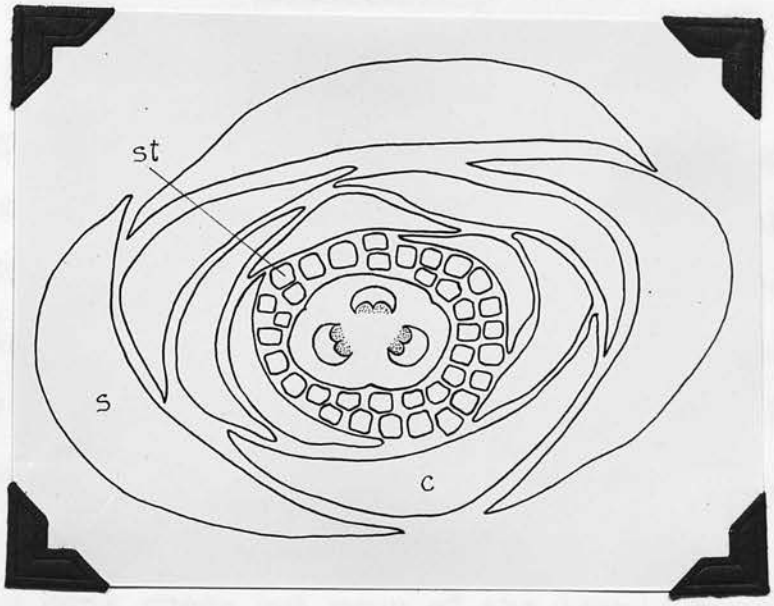
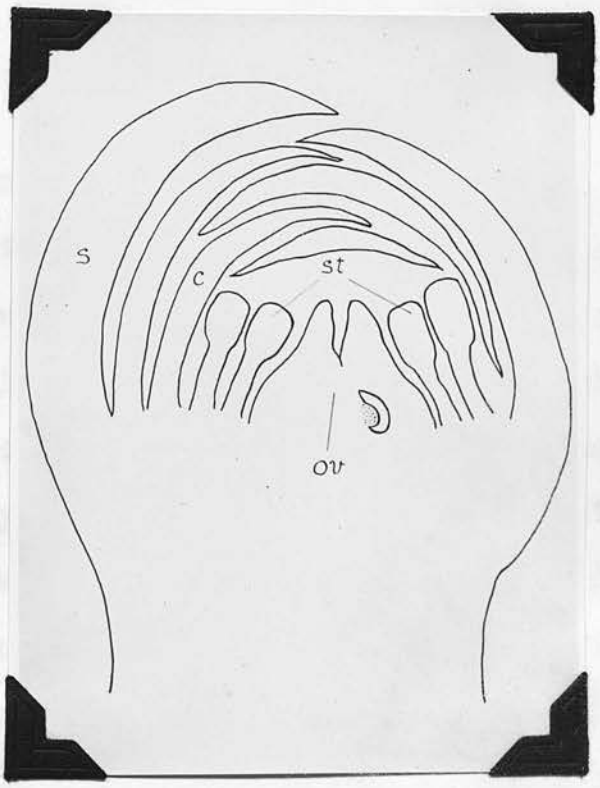


Fig. 4.



4. TERNSTROEMIA JAPONICA, THUNB.

INTRODUCTION.

The genus TERNSTROEMIA consists of trees and evergreen shrubs found in tropical America and the warmer parts of Asia and the Indian Archipelago. TERNSTROEMIA JAPONICA is an evergreen shrub reaching a height of about four feet. The plant is extensively branched, the branches being flattened and spreading. The leaves are alternate, entire, coriaceous and exstipulate. The leaf colour is mostly dark green but many of the leaves have a red pigment, particularly towards the apex. The flowers are produced in late July and early August. They are axillary and all face downwards.

FLORAL DESCRIPTION.

INFLORESCENCE - The flowers are solitary, in pairs, or disposed in short cymes, in the axils of the upper leaves. Each flower is carried on a well developed pedicel, and is subtended by one or several small bracteoles which are shed early in development. All the pedicels curve downwards, so that the flowers are found on the under side of the branches, facing downwards, covered by the leaves.

RECEPTACLE - Shortly convex.

FLOWER - Hermaphrodite and regular, about half an inch in diameter.

CALYX - Five sepals which are imbricated, arranged in quincunial prefloration. The sepals are orbicular and green in colour with a red pigmented fringe round the margin.

COROLLA - Five petals alternating with the sepals, scarcely united at their base, and imbricating in the same manner as the sepals. The petals are white in colour with a slight red tinge at the base.

ANDROECIUM - The androecium is formed of an indefinite number of hypogynous stamens. The filaments are united for a very short distance with the base of the corolla and surmounted by basifixed anthers. The anthers are ciliated, adnate, and crowned by a pointed prolongation of the connective. They dehisc by longitudinal clefts.

GYNOECIUM - The gynoecium is superior formed of an ovary with two cells, tapering above into a long style which forks at the end into two stigmata. In the internal angle of each cell a wide short placenta is inserted, the inferior edge supporting from 5-8 suspended anatropous ovules, with micropyles looking upwards and inwards.

DEVELOPMENT OF THE FLOWER.

CALYX.

The flower is usually subtended by two small bracteoles which arise laterally. The first bracteole arises to the right of the median line and the second to the left. The sepals are spiral in origin and also in arrangement (Fig.1.). The first sepal is anterior and to the right of the median line. The second sepal is distinctly posterior. The third is anterior to the left of the median line. The fourth and fifth arise laterally to the right and left respectively of the median line. This spiral arrangement is a type of quincuncial prefloration, but it differs from the other pentamerous types in that it turns in the reverse manner.

COROLLA.

The petals are free but even in the youngest buds they are never found discrete. They are spiral in origin and imbricate at a very early stage, the imbrication following the spiral already formed by the sepals (Fig.1.). The first petal is distinctly anterior. The second is posterior to the right of the median line. The third is lateral to the left of the median line. The fourth is lateral to the right and the fifth posterior to the left of the median/

median line. Thus the sepals and petals together form a continuous spiral which is reverse in direction to the usual type. In several flowers it was observed that the petals showed a tendency to cohesion at the base, but this was not observed in sections of young flower buds.

ANDROECIUM.

The fully developed flower has an indefinite number of stamens, showing no indication of being arranged in bundles, but they are not spiral in origin. A certain amount of incomplete splitting may be found, and it is in this manner that the large number of stamens arise. In cutting young flower buds it was found that, at a very early stage, only five stamens were present (Fig.1.). These five stamens are opposite the sepals. Sections of flower buds at a slightly further advanced stage showed from ten to fifteen stamens, a further five stamens having arisen opposite the petals. In cases where more than ten stamens were found, evidence of splitting could be made out. This splitting from the original ten gives rise later to an indefinite number of stamens. (Fig.3.).

GYNOECIUM.

The ovary arises as two separate carpellary growths,/

growths, one anterior and the other posterior (Figs. 1 and 2.). In transverse section they are curved with the edges facing each other. As development proceeds the two young carpels meet at their edges and fuse from below upwards, to form a small cup like structure. The next step in development shows that at the point of fusion of the carpels on either side, the ovary wall forms two protuberances on the inside. These two protuberances then commence to grow in towards the centre where they finally meet and fuse. This fusion takes place gradually from below upwards to form the two loculi of the ovary (Figs. 3 and 4.). After fusion the ingrowths turn slightly into each cavity to form the placentae.

EXPLANATION OF FIGURES.

Fig.1. - Transverse section of a young flower bud. X 80. b - bract, br - bracteole, s - sepal, c - corolla, st - stamen, ov - ovary.

Fig.2. - Longitudinal section of a young flower bud. X 80. Lettering as in Fig.1.

Fig.3. - Transverse section of a further advanced flower bud. X 80. Lettering as in Fig.1.

Fig.4./

Fig.4. - Longitudinal section of a further advanced flower bud. X 80.

Lettering as in Fig.1.

TERNSTROEMIA JAPONICA.

FIG. 1.

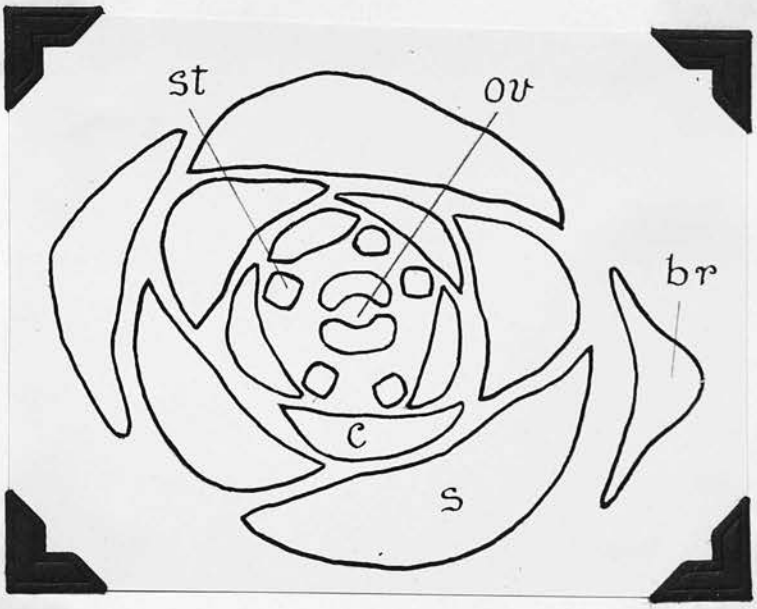


FIG. 2.

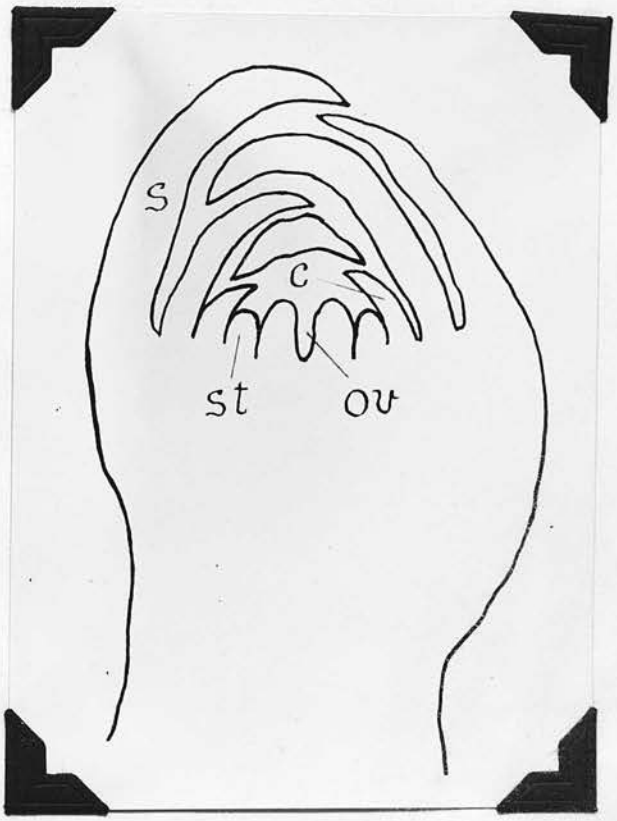


Fig. 3.

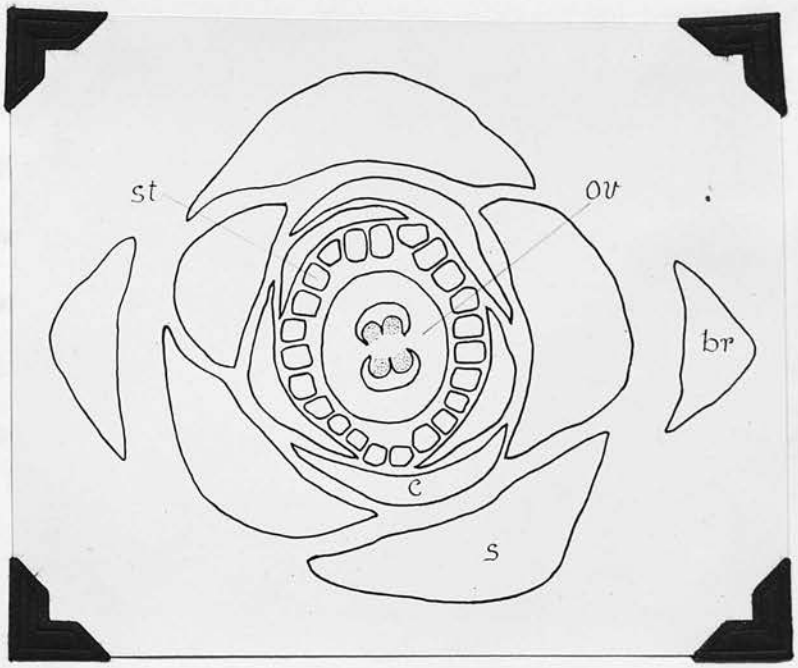
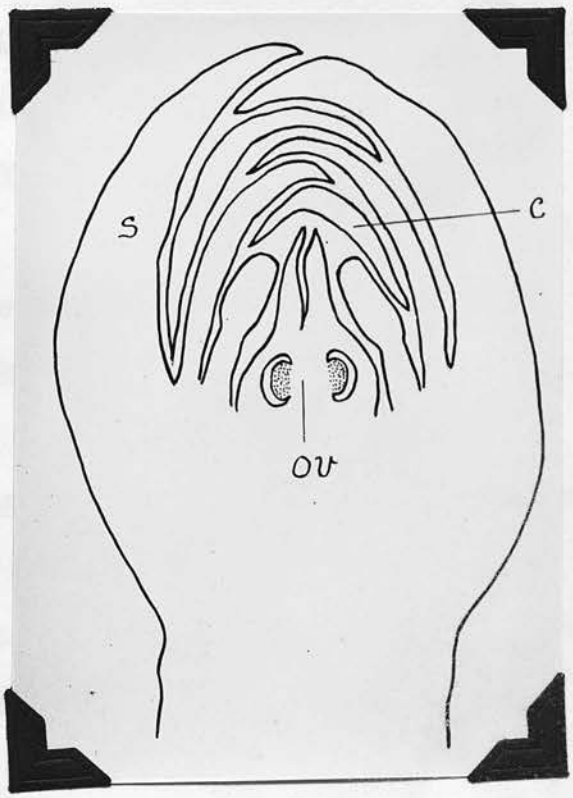


Fig. 4.



5. VISNEA MOCANERA, LINN.

INTRODUCTION.

The genus VISNEA is monotypic and is found in the Canary Islands and Madeira. The plant takes the form of an evergreen shrub which may reach a height of about ten feet. The leaves are alternate, coriaceous and exstipulate. The flowers are produced in October and November and are axillary.

FLORAL DESCRIPTION.

INFLORESCENCE - The flowers are produced solitary or in pairs in the axils of the outer leaves. Each flower is carried on a well developed pedicel and is subtended by a bract and two small bracteoles. As in TERNSTROEMIA JAPONICA all the pedicels are curved down under the leaves with the result that the flowers all face downwards.

RECEPTACLE - Shortly cupuliform, making the perianth and stamens perigynous.

FLOWER - Hermaphrodite and regular, about half an inch in diameter.

CALYX - Five sepals which are imbricated in quin-

quincuncial prefloration. The sepals are green in colour, pointed and pubescent.

COROLLA - Five petals alternating with the sepals, imbricated in the same prefloration and quite free. The petals are white in colour.

ANDROECIUM - The androecium is formed of from 10-20 stamens which are free. The filaments are surmounted by basifixed anthers which are adnate, and, as in TERNSTROEMIA JAPONICA, are crowned with a pointed prolongation of the connective. The anthers dehisce by longitudinal clefts.

GYNOECIUM - The ovary is three celled, slightly immersed in the receptacle. There are three distinct styles. The upper part of the ovary is ribbed vertically and is strongly pubescent. This pubescence is found also on the styles at their base. In the inner angle of each cell are found 2-3 descending ovules attached to an axile placenta.

DEVELOPMENT OF THE FLOWER.

CALYX.

The flower is subtended by a bract and two lateral bracteoles, but the bract is shed very early in development and does not appear in sections. The first bracteole to develop is that on the left side/

side of the median line. The second bracteole arises on the right side, laterally opposed to the first. The sepals are again spiral in origin and arrangement (Fig.1.). The first sepal is anterior to the left of the median line. The second is distinctly posterior. The third is anterior to the right of the median line. The fourth and fifth arise laterally or nearly so, to the left and right of the median line. This is exactly the same type of quincuncial prefloration as that found in the calyx of SAURAUJA SUBSPINOSA.

COROLLA.

The spiral arrangement of the calyx is carried into the corolla (Fig.1.). The petals are never found discrete. They are spiral in origin and imbricate at a very early stage. The first petal is distinctly anterior. The second petal is posterior to the left of the median line. The third is lateral to the right, the fourth is anterior to the left, and the fifth posterior to the right of the median line. This is exactly the same type of prefloration found in the corolla of SAURAUJA SUBSPINOSA.

ANDROECIUM.

The number of stamens in the fully developed flower/

flower varies from 10-20, though in some cases as many as 25 may be found. A transverse section of a very young flower bud may show 10 stamens, five opposite the sepals and five opposite the petals (Fig.1.). The five opposite the sepals are slightly further out and probably arose first. This condition may prevail in a few cases until full development of the flower is reached. Generally, however, the flowers have approximately 20 stamens (Fig.3.), the increase in number having been brought about by splitting of the original stamens. In all sections showing more than 10 stamens, evidence of splitting may be found.

GYNOECIUM.

The ovary is slightly sunk into the receptacle, but it arises originally as three separate carpels (Figs. 1 and 2.). The carpels arise opposite the first three sepals and are slightly curved inwards. As development continues the carpels meet at their edges and fusion takes place from below upwards. A cup like structure is thus formed with the lower half immersed in the receptacle. In the next stage of development the ovary wall forms three protuberances on the inside, opposite the points of fusion of the carpels. The protuberances then grow inwards towards the centre where they meet and fuse to form the/

the three loculi (Fig.3.). Fusion again takes place from below upwards (Fig.4.). The placentae are again formed by the slight turning in of the fused carpels into each cavity.

EXPLANATION OF FIGURES.

Fig.1. - Transverse section of a young flower bud. X 80. b - bract, br - bracteole, s - sepal, c - corolla, st - stamens, ov - ovary.

Fig.2. - Longitudinal section of a young flower bud. X 80. Lettering as in Fig.1.

Fig.3. - Transverse section of a further advanced flower bud. X 80. Lettering as in Fig.1.

Fig.4. - Longitudinal section of a further advanced flower bud. X 80. Lettering as in Fig.1.

VISNEA MOCANERA.

FIG. 1.

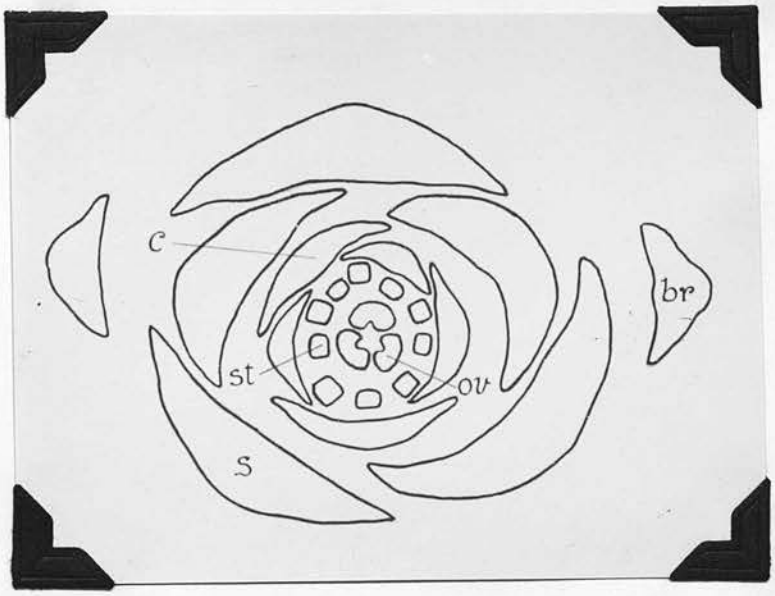


FIG. 2.

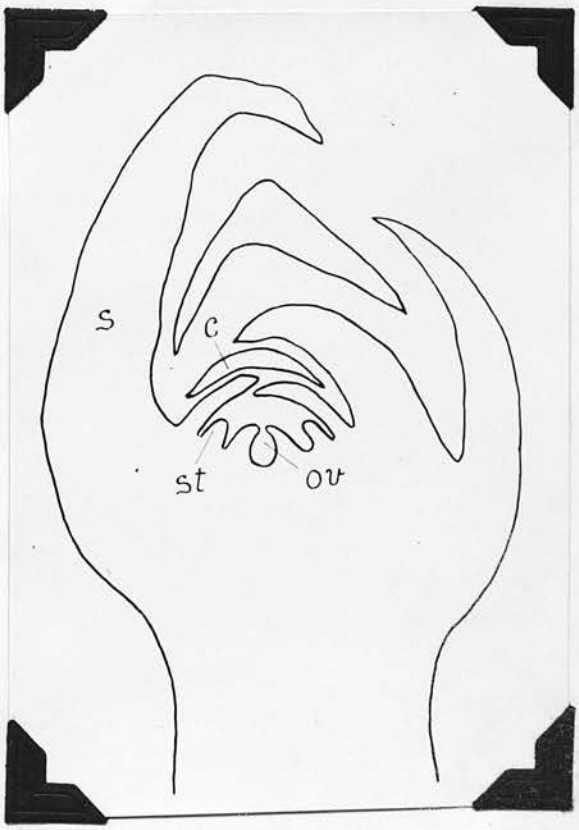


Fig. 3.

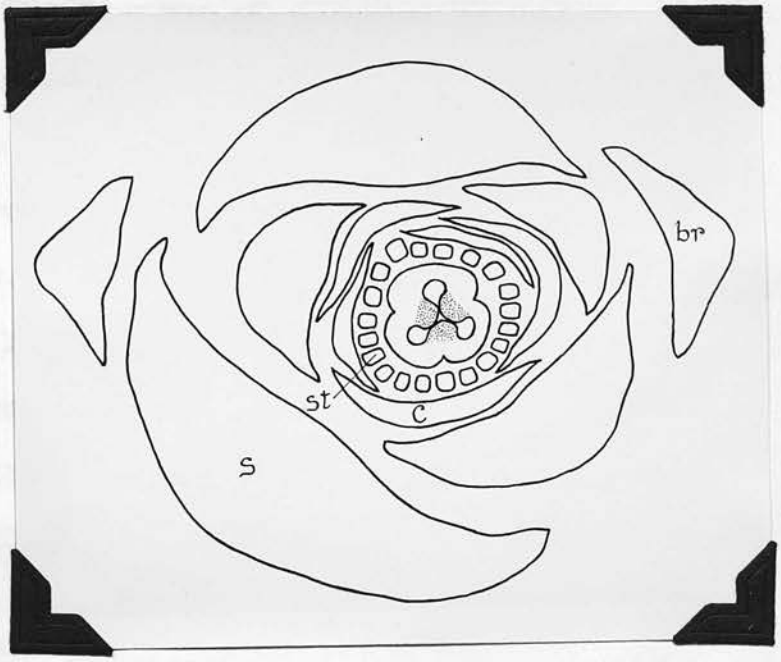
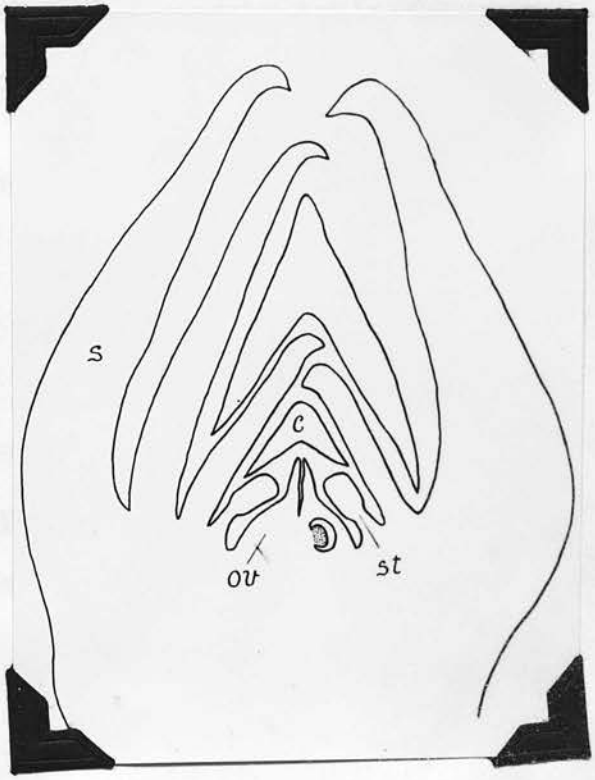


Fig. 4.



DISCUSSION AND CONCLUSION.

The flowers of all the types described are pentamerous with the one exception, STACHYURUS, which is tetramerous and will be considered alone after a general discussion of the development in the other types. All the plants studied are similar in that they have one or more small bracts subtending the flower. In the development of the calyx, three of the types, SAURAUJA, CAMELLIA, and VISNEA, are exactly similar. The sepals arise in a spiral formation and the quincuncial prefloration in each type is identical.

In TERNSTROEMIA we also find the sepals originating in a spiral manner, and again the prefloration is quincuncial, but the spiral takes exactly the reverse form from that found in the other three types.

cultivation, shows a tendency to increase the number of petals. The species of SAURAUJA studied isolates itself in the development of the corolla as the petals are cyclic in origin and a decidedly gamopetalous corolla is formed. This is a decided step forward, and a very slight trend in this direction may be found in certain flowers of TERNSTROEMIA JAPONICA in which the petals are very scarcely united at the base, and the stamens adhere slightly to the base of the corolla.

In/

In considering the development of the androecium the evidence shows that, although they have an indefinite number of stamens in the fully developed flower, the types are fundamentally diplostemonous. It has been stated by Warming (9), and is generally accepted, that in Ternstroemiaceae the numerous stamens are always formed by the splitting of a small number; a true spiral arrangement never being found. In SAURAUJA the multiplication of the stamens is brought about by the splitting of the original whorl opposite the petals, tending to give the appearance of bundles of stamens opposite the petals in the mature flower. This is rather obscure in SAURAUJA SUBSPINOSA, as the numerous stamens are closely pressed together in such a small flower and the corolla is decidedly gamopetalous.

It is possible to trace an evolutionary progression among certain members of Ternstroemiaceae with regard to the character of the androecium. The primitive condition in this progression is that in which the stamens are ten in number, forming two whorls, and this may be exemplified by VISNEA MOCANERA. Passing from this we come to the condition found in SAURAUJA SUBSPINOSA, in which ten stamens are again present in two whorls, but numerous stamens are formed by the splitting of the petal-stamens. In this case the sepal-stamens are present but do not split. The suppression of the sepal-stamens forms the next step

in the progression. This is found in SAURAUJA LANCEOLATA (7), KIELMEYERA (9), and GORDONIA (8), which have numerous stamens produced by the splitting of the five original petal-stamens; the sepal-stamens being suppressed. In this case the arrangement of the stamens in bundles opposite the petals is more distinct. In this general trend the efficiency of the stamens produced by the splitting of the petal-stamens would lead to the suppression of the other whorl opposite the sepals. The formation of numerous stamens by the splitting of the five original petal-stamens would lead to the arrangement of bundles of stamens opposite the petals.

In CAMELLIA and TERNSTROEMIA the numerous stamens are cyclic but show no tendency to be arranged in bundles. They have probably been derived from a type having ten stamens, by the splitting of all the original stamens.

Although the number of carpels varies in the types from 2-5, there is a marked similarity in the development of the gynoecium. The ovary always arises in the first place as separate carpels, which fuse very early in development to form a syncarpous ovary. Then according to the number of carpels, a series of ingrowths are formed at the points of fusion of the carpels, or rather the fused edges of the carpels grow inwards and meet at the centre to form a central

column/

column, dividing the ovary into its loculi. The placenta is always found in the internal angle of the loculus, and is formed by the turning into the loculus of the fused edges of the carpels. Thus the placenta in each loculus is really made up of the two edges of the original carpel which forms that loculus.

Taking STACHYURUS alone we find a distinctly tetramerous flower. The sepals arise in an alternate manner, but do not form a true spiral arrangement. The petals are cyclic in origin but like the sepals they imbricate strongly in the bud. The flower is diplostemonous showing a regular alternation of 4 sepals, 4 petals, 8 stamens and 4 carpels. There is no tendency to increase the number of stamens by splitting. The development of the ovary is essentially similar in nature to that of the other types. This genus was included in Ternstroemiaceae by Bentham and Hooker (3), but other systematists have referred it to Pittosporaceae (2), and recently it has been studied as a separate family.

The inflorescence of SAURAUJA shows an interesting series of movements correlated with the pollination of the plant. In STACHYURUS the flowers are produced in raceme but no movements of the inflorescence were observed which might be associated with pollination. Very little can be said regarding the inflorescence in the other types, as the flowers are produced solitary, in/

in pairs, or in small cymes. In these types also no observations were made which could give any guide to the pollination mechanism of the plants. It is interesting to note, however, that in both VISNEA and TERNSTROEMIA all the flowers face downwards but the fruits become erect. This has been shown to be correlated with the pollination in SAURAUJA, and it probably has the same significance in the other two types.

SUMMARY.

This paper gives a detailed description of the development of the flower parts in certain types of Ternstroemiaceae. The types studied are the following:-

SAURAUJA SUBSPINOSA, ANTH.

STACHYURUS CHINENSIS, FRANCH.

CAMELLIA CUSPIDATA, COHEN STUART.

TERNSTROEMIA JAPONICA, THUNB.

VISNEA MOCANERA, LINN.

The main points brought out may be summarised as follows. The perianth shows a general tendency to be spiral in origin, resulting in the imbrication of the parts in the bud. The flowers are fundamentally diplostemonous despite the fact that an indefinite number/

number of stamens is usually found in the fully developed flower.

The syncarpous ovary of 2-5 cells with axile placentation is formed by the early fusing of separate carpels at their edges; the fused carpels then grow inwards to the centre where they meet and fuse to form the central column of the ovary.

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(8)/

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