Pharmacognostical Studies of Vera Cruz and Tampico jalap

by E. J. SHELLARD (1)

Vera Cruz Jalap

The drug known as jalap has been imported into Europe from Mexico for hundreds of years, though it is not certain when the first shipments were made and there is very strong evidence to suggest that the drug was not always obtained from the same botanical source. The value of Convolvulaceous drugs lies in the purgative nature of their latex, which when extracted with alcohol and the concentrated alcoholic extract poured into water, yields the so-called resins. Jalap, together with its resin and the ether insoluble portion of the resin (known on the continent of Europe as convolvulin and in Britain as jalapin) was extremely popular several years ago and although its use as a purgative is now regarded by the medical profession with some disfavour it is still extensively used in many proprietary medicines.

Today, the drug is known as Vera Cruz jalap and consists of the dried whole tubercles of *Ipomoea purga* Hayne, though it is not known when the drug consisted of tubercles solely from this plant. The anatomical descriptions of jalap made during the last 110 years are lacking either in detail or in suitable illustrations but the different reports tend to confirm the view that the commercial material has been obtained from at least two distinct plants.

Pereira (1850) made no mention of the anatomy of the drug other than in the sentence "the transverse surface was interspersed with deep brown concentric circles" and this is the description given in the earlier British Pharmacopoeias.

The first known account giving any detail of the anatomy was that by Berg (1865). Describing the transverse surface he says, "bark very thin, separated from the wood by a dark resing ring; wood with numerous, concentric, wider and narrower dark brown zones, which consist of resin cells and groups of vessels". The description is illus-

(1) School of Pharmacy, Chelsea College of Science & Technology, Manresa Road, Chelsea, London, S. W. 3. England.

NOTE:—In this article μ=millimicron.

trated with a drawing of a transverse section of a tuber to show the distribution of the concentric zones and of a segment through a tertiary cambium zone. (Figure 2)

Similar descriptions to that given by Berg (though not always with the same degree of detail) were given by Flückiger and Hanbury (1879), Vogl (1887). Herail and Bonnet (1891), Herlant (1892), Moeller (1892), (1898), Berg and Schmidt (1892) and Koch (1901). It is not certain whether these authors examined the drug microscopically themselves or merely reported Berg's work. Herlant did, however, describe the starch grains in detail and reported them as measuring from 0.015 to 0.082 mm. in diameter. Schmidt (1875) also made a detailed examination in connection with the development of the abnormal cambia but his description is similar to that of Berg so it is evident that in the latter half of the 19th century tubercles answering this description were commercially available as jalap.

From the account of the anatomy of jalap given by Planchon and Collin (1895) it would appear that they described tubers which differed from those previously examined. Tschirch (1889) also described tubers and included a drawing which showed the formation of circular and horseshoe shaped cambia as described by Planchon and this was confirmed by Koch (1914) though he did not give a botanical source for the tubercles examined.

In 1923, however, Moll and Janssonius published a very detailed account of an examination of the tubercles of *Ipomoea purga* Hayne which they had carried out in 1901. They had established the identity of their material by growing the plants at the University of Groningen and used tubercles from these plants. Their report includes line drawings of the arrangements of the cambia but not detailed drawings of the histological features. The description was later confirmed by Wallis when he examined the drug in preparation for the monograph in the 6th British Pharmacopoeia 1932. He subsequently included some details in his "Textbook of Pharmacognosy" (1946) and these are also in the later editions. Trease (1934) included a description of the structure of jalap in his textbook, giving an account of the formation of tertiary cambia according to Planchon. In a later edition (1957) he included the drawings by Moll and Janssonius. The account given by Flück, Schlumpf and Siegfried (1935), which includes a photomicrograph of the transverse section is also similar to that of Moll and Janssonius. In fact, most authors of textbooks of pharmacognosy published after 1923 give a description of the anatomy of Vera Cruz jalap which was based on the work of Moll and Janssonius. The books include those by Gilg, Brandt and Schürhoff (1927), Karsten and Benecke (1928), Wasicky and others (1936), Planchon, Bretin and Manceau (1938) and Perrot (1942-3). It is most surprising therefore, to find that a few authors continued to describe the drug according to Berg. These are Wall and Suppan (1928), Thoms (1931) and Youngken (1950). The first and last named books supported their descriptions by including reproductions of the drawings of the transverse sections of the tubercle given by Berg in his Atlas.

Macroscopical characters

A number of samples of Vera Cruz jalap supplied by drug brokers, merchants and wholesalers between 1950 and 1959 have been examined and all of them consist of dried whole tubercles, the majority of which are fusiform, napiform, or conical in shape. A few could be described as irregularly oblong and others as almost spherical. They measure from 3 to 18 cms. long and 1 to 8 cms. wide though the majority of the tubercles are 8 to 10 cms. long and 4 to 5 cms. wide. The upper end is rounded and often shows a scar where the tubercle was broken from the rest of the root. The lower end tapers to a bluntly pointed apex. On the outside of the tubercles there is a dark brown wrinkled cork showing numerous elongated transverse lenticels which are lighter than the cork itself (Figure 1).

The tubercles are extremely hard and compact and very difficult to break. They have a slightly smoky odour and a taste that is sweetish at first but afterwards is distinctly acrid.

The appearance of the smoothed transverse surface is characterised by a complete circular secondary cambium just inside the cork layer and by a large parenchymatous xylem in which are numerous tertiary cambia. (Figure 3). The actual arrangements of the tertiary cambia may, however, vary quite considerably. In some tubercles a number of these cambia may be arranged as complete circles concentric with the secondary cambium while in other tubercles such cambia are entirely absent. The tertiary cambia may also take the form of small circles or they may be linear or horse-shoe shaped or elliptical in outline (Figure 3).

The smoothed transverse surface also shows the presence of small isolated groups of xylem elements near to each cambium and rows of black dots along each cambial line but always on the side of the line opposite to the xylem groups.

Microscopical features

The cork consists of about 10 to 15 rows of brick-shaped cells arranged in regular radial, tangential and longitudinal rows except towards the outside where some exfoliation occurs and the cells are somewhat compressed. The individual cells are 40 to 100u long, 20 to 50u wide and 5 to 15u high. In surface view thay appear square or rectangular in shape. The rectangular and irregular-shaped cells are usually elongated in the direction of tangential growth. (Figure 5 c). The cell walls which are suberised, are thin (except in the outermost regions), pale brown and non-lignified or only very slightly lignified. Towards the outer region where compression of the cells occurs, the radial and outer tangential cell walls are thickened with brown suberised material (Figure 4).

The phellogen is not readily discernible but there is a distinct and often fairly extensive phelloderm. The outer layer of the phelloderm consists of regularly arranged rectangular cells while the inner layer consists of irregularly-shaped cells with the occasional sclereid but with

frequent latex cells. The sclereids measure from 50 to 120*u* long, 30 to 80*u* wide and 30 to 80*u* high. The lignified cell wall, 10 to 15*u* thick, shows stratification and branched simple pits. The latex cells are arranged in longitudinal rows of 2 to 12 cells. The cells are sometimes elongated longitudinally and sometimes radially or tangentially, and frequently they are much greater in tangential or radial measurement than they are longitudinally. Their sizes are R and T = 50 to 100*u* and occasionally up to 185u, L = 30 to 150*u* (Figures 4 and 5A). The cell walls are thin, suberised but not lignified. The latex is soluble in solution of chloral hydrate, solution of sodium or potassium hydroxide and alcohol and it stains yellow with solution of iodine.

Cells of the phelloderm also contain cluster crystals of calcium oxalate. These are scattered irregularly throughout the tissue with up to two or three crystals in a cell. They measure from 5.5 to 30.0*u* in diameter. A few small prismatic crystals up to 7 or 8*u* long are also present (Figure 5D). Apart from the few sclereids, the latex cells and the cells containing crystals of calcium oxalate the cells of the phelloderm are packed with starch grains. The grains are round, oval or semifaceted in shape. The round and oval grains are single grains but the muller-shaped ones are in aggregates which may have from 2 to 8 (and occasionally more) components. The size of the individual grains vary from 1.85 to 42.0*u* in diameter but some gelatinised starch grains are present in some samples and these may measure up to 85u diameter. The hilum is readily visible, especially in the larger grains and is eccentrically placed. It takes the form of a point or a biradiate cleft. The striations are faintly visible in some grains (Figure 5E).

The remainder of the tissue external to the secondary cambium consists of secondary phloem. This is made up chiefly of small thin-walled parenchymatous cells filled with starch or containing cluster crystals of calcium oxalate. Small groups of sieve tissue are also present and there are longitudinally arranged rows of latex cells. There are no phloem fibres. Where the secondary phloem impinges on the phelloderm the tissue is often crushed. In the zone nearest to the cambium the radial arrangement of the cells is very apparent but farther away from the cambium the cells become somewhat irregular in shape. Occasionally the beginning of a uniseriate medullary ray may be seen but they rarely extend very far into the phloem tissue. This is because of the development of the large latex cells. The cells of the medullary rays are larger than the rest of the phloem parenchyma and are elongated radially. Their dimensions are R and L up to 24*u* and T up to 60*u*. They cannot easily be seen in tangential longitudinal sections but in radial longitudinal sections are seen as bands of cells, 5 to 8 cells hign. All the medullary cells are packed with starch. Very little sieve tissue is present but isolated groups of 5 to 12 sieve tubes can be seen near to the cambium in transverse and in longitudinal sections. The sieve plate ends are obliquely arranged and the sieve areas are divided into groups. The most prominent feature of the secondary phloem are the latex cells. They are arranged in a similar manner to those in the phelloderm. They appear to be slightly smaller though their range

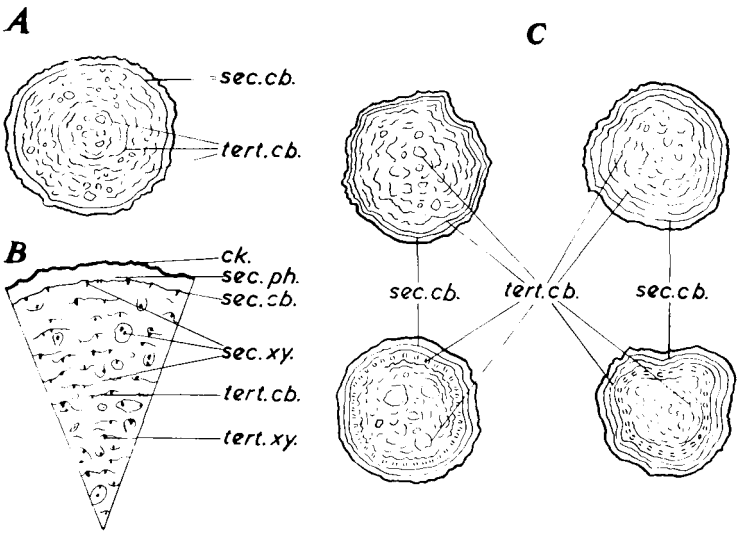

Figure 3. (ABOVE)

A and B. Transverse surface of Vera Cruz jalap showing typical pattern of secondary and tertiary cambia. A X 1. B X 2.

C. Transverse surface of Vera Cruz jalap showing variations in the patterns of tertiary cambia. X 1.

ck. cork; sec. cb. secondary cambium; sec. ph. secondary phloem; sec. xy. secondary xylem; tert. cb. tertiary cambium; tert. xy. tertiary xylem.

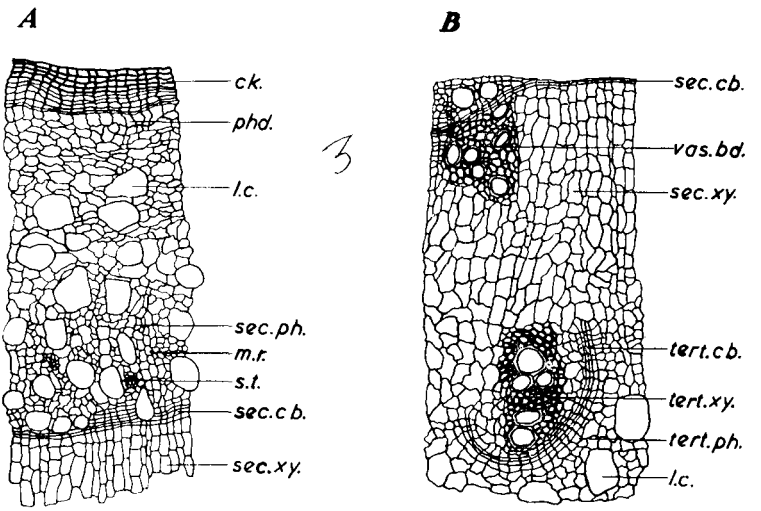

Figure 4. (BELOW)

A. Transverse section of Vera Cruz jalap showing tissues external to the secondary cambium X 60.

B. Transverse section of Vera Cruz jalap showing secondary xylem and formation of tertiary cambium X 60.
ck. cork; phd. phelloderm; sec. ph. secondary phoem; sec. cb. secondary cambium; sec. xy. secondary xylem; tert. ph. tertiary phloem; tert. cb. tertiary cambium; tert. xy. tertiary xylem; l. c. latex cell; m. r. medullary rap; s. t. sieve tiessue; vas. bd. vascular bundle.

of sizes is the same. There may be as many as 20 cells in a longitudinal row

The starch is similar to that in the phelloderm. The crystals of calcium oxalate are also similar to those in the phelloderm, except that they are arranged in distinct longitudinal rows of 24 to 30 crystals in 5 or 6 cells (Figure 5B).

The secondary cambial zone appears as 3 to 5 rows of narrow rectangular cells, slightly elongated tangentially.

The secondary xylem consists chiefly of parenchymatous cells which are produced in regular radial rows from the cambium. The cells are elongated radially; some are long and narrow and others are quite wide but it is not possible to discern with any certainty in any of the sectional views, rows of cells which could be described as medullary rays. The dimensions of the cells are R = 20 to 150*u*. T = 10 to 75*u* and L = 50 to 100*u*. All these cells are filled with starch similar to the starch already described but there are no crystals of calcium oxalate. Nearer to the centre of the root the cells do not show any regularity in shape or arrangement. There are no latex cells in the xylem.

Lying adjacent to, and having been cut off from the secondary cambium on the inside are the small, scattered bundles of lignigfied tracheal elements. Similar groups of lignified elements are scattered throughout the entire xylem. They contain vessels either singly or in groups of two or three. The bundles may contain from 1 to 6 or occasionally up to 10 vessels. The vessels have thickened lignified walls. (Figure 6A). The majority of the vessels have elongated bordered pits but some have more oval or round bordered pits. A few have scalariform — reticulate thickening. The vessel segments measure L = 50 to 140*u* and R = T = 20 to 100*u* with some up to 175*u*. Those with the elongated pits are long and have small diameters while those with the round bordered pits are very short and have large diameters. (Figure 6A). In addition to the vessels the bundles contain tracheidal vessels, tracheids and fibre tracheids. There are no true fibres. Tracheidal vessels are very common. There appear to be two types, one having two pores, one at each end of the cell on the inclined surface at the places of contact with the neighbouring tracheidal vessels (Figure 6B) and the others having a similar pore at one end only and a complete transverse perforation at the other end. (Figure 6C). The former type are very characteristic in shape and are sometimes arcuate and sinuous. They have elongated bordered pits with oblique slits. They measure L = 150 to 300*u* and R = T = 25 to 45*u*. The second type look like small vessels and have elongated oval bordered pits. They measure L = 90 to 150*u* and R = T = 30 to 60*u*. The tracheids are longer and wider measuring L = 200 to 400*u* and R = T = 25 to 50*u*. They have elongated bordered pits but are without the pores at the end of the cells. The fibre tracheids have slightly thicker walls than the tracheids 1 and tracheidal vessels and have oblique slit-like pits. Their dimensions are L = 225 to 550*u* and R = T = 15 to 30*u* (Figure 6C).

All the tertiary tissues are within the secondary tissues, tertiary cambia being readily discernible in the secondary xylem parenchyma. In the examples examined the tertiary cambia take many forms. Some are large, circular and concentric with the secondary cambium. Groups of xylem elements which are adjacent to these are obviously tertiary xylems and are formed sometimes on the outside of the cambium and sometimes on the inside. Other tertiary cambia are small, circular and enclose one or two small xylem groups but do not touch them in every case. Again, some are elliptical, others are linear in the vicinity of a xylem group and there are some linear cambia which are not near to any xylem elements. It is not possible therefore to say in every case which is tertiary xylem. Histologically the elements present are identical with those in the secondary xylem. There is no doubt about the tertiary phloem however. This is always formed by a tertiary cambium on the side opposite to the xylem elements present. It consists of parenchyma and longitudinal rows of large latex cells similar in size to those in the secondary phloem. Sieve tissue does not appear to be developed in the tertiary phloem.

Tampico jalapa

Towards the middle of the last century, tubercles which closely resembled jalap were exported as a substitute for jalap and since they came via the town of Tampico became known as Tampico jalap. They yielded 10 — 15% of resin which, however, was completely soluble in ether so that they were never accepted as a suitable substitute for the official drug.

The botanical source was not known until Hanbury (1869) examined the plant and named it *Ipomoea simulans* because it was very similar to *Ipomoea purga* Hayne.

The tubercles of Tampico jalap are not a commercial drug in Europe today but they do occur quite frequently in batches of Vera Cruz jalap and are thus regarded as an adulterant. The macroscopical features of the tubercles were described by Hanbury (1869) but no anatomical examination appears to have been reported. Such an examination was therefore made of tubercles which have been found on various occasions in admixture with Vera Cruz jalap. They were identified originally by means of their morphological appearance as described by Hanbury and later confirmed by comparison with the specimens in the Museum of the Pharmaceutical Society which had been presented by Hanbury. The identification was subsequently supported by the complete solubility in ether of the resin obtained from the tubercles.

Macroscopical characters

The drug consists of whole dried tubercles which vary in size and shape. The majority are fusiform but some are irregularly spherical or cylindrical. They measure from 3 to 15 cm. long and from 2 to 10 cm. wide. Like Vera Cruz jalap the upper end often shows a scar.

The surface of the tubercles is a very dark, almost black, cork

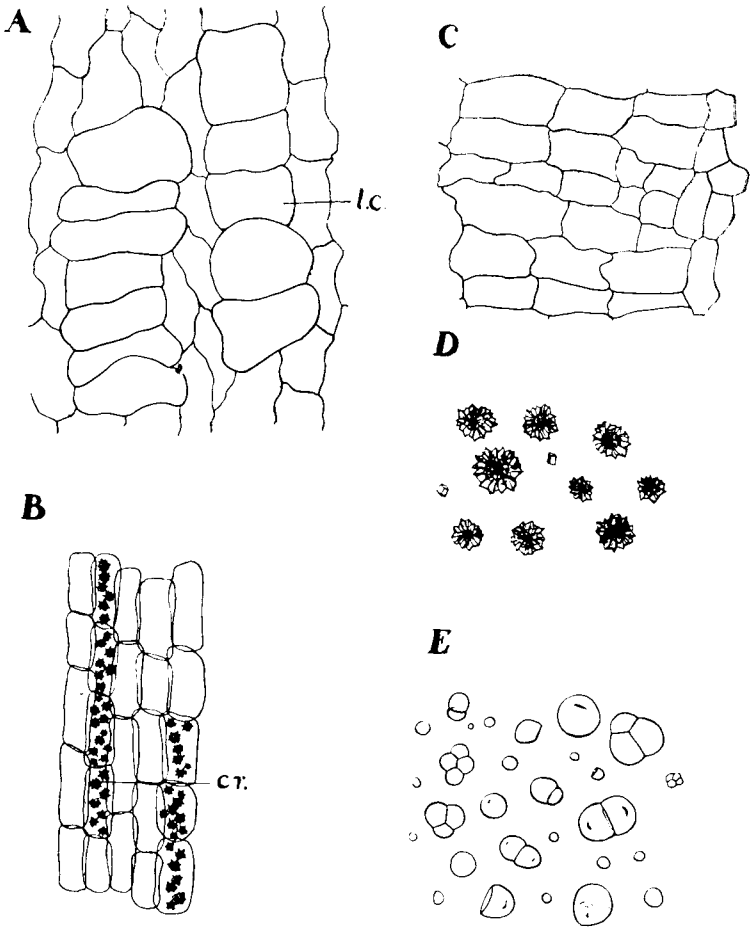

Figure 5. **VERA CRUZ JALAP.**

A. Latex cell (R. L. S.) X 120.
B. Phelloderm (R. L. S.) X 80.
C. Cork (surface view) X 120.
D. Calcium oxalate X 180.
E. Starch X 180.

l. c. latex cells; cr. crystal of calcium oxalate.

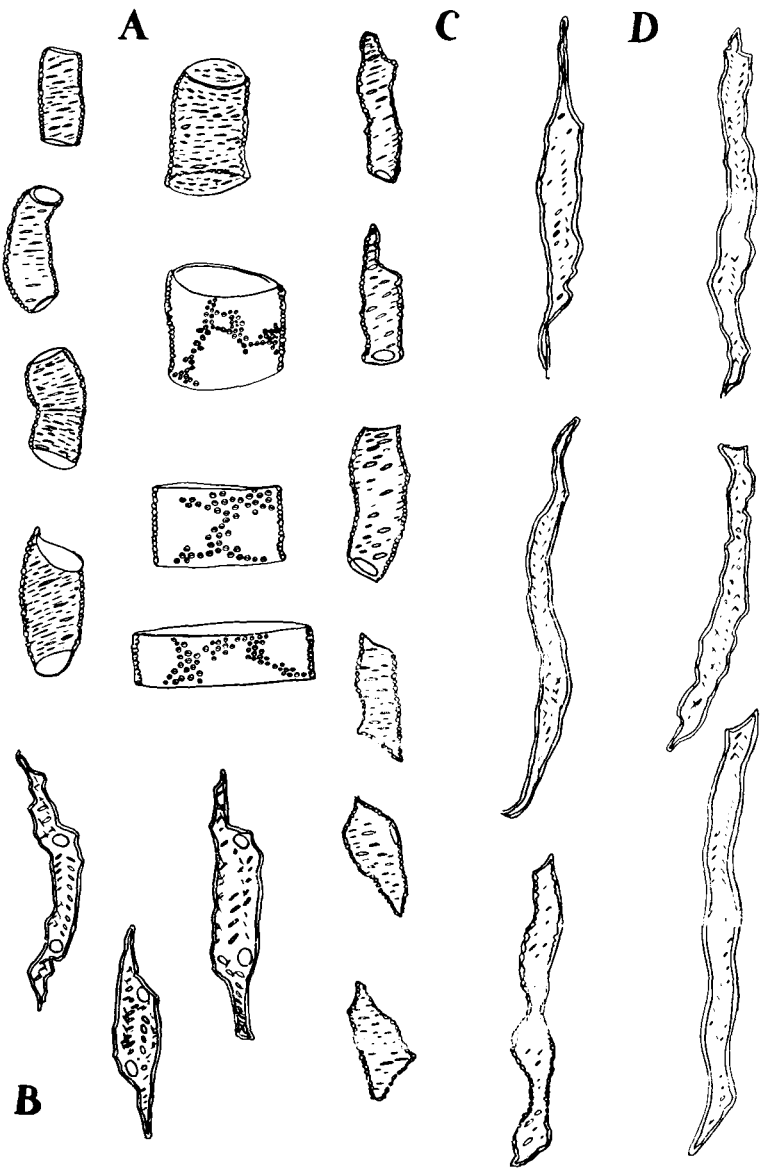

Figure 6. **ISOLATED LIGNIFIED ELEMENTS OF VERA CRUZ JALAP** X 120.

A. Vessels.
B. Tracheidal vessels.
C. Tracheidal vessels.
D. Fibre tracheids.

which is smooth and devoid of lenticels. Some of the tubercles show numerous short deep furrows irregularly arranged but most of them have longer furrows arranged longitudinally giving the tubercles a convoluted appearance. They are very hard and difficult to break. They have practically no odour and a taste which is sweetish at first but later becomes distinctly acrid. (Figure 1).

The smoothed transverse surface has an appearance which is very similar to that exhibited by Vera Cruz jalap. It is characterised by a complete circular secondary cambium just inside the cork layer and a large parenchymatous xylem in which are numerous tertiary cambia. Like Vera Cruz jalap, these cambia may take the form of complete circles concentric with the secondary cambium or they may be linear, horse-shoe shaped, irregularly circular or elliptical (Figure 8A and B). The smoothed transverse surface also showed the presence of small isolated groups of xylem elements near to each cambium and rows of black dots along the lines of the cambia but always on the side opposite to the xylem groups.

Microscopical features

The cork consist of about 8 to 20 rows of brick-shaped cells arranged in regular radial, tangential and longitudinal rows. There is little compression of the cells towards the outside and there is no apparent exfoliation. The individual cells measure 35 to 100u long, 20 to 50u wide and 5 to 15u high. In surface view they appear square or rectangular though some are polygonal or irregular in shape (Figure 9B and C). The cell walls, which are thin and pale brown are suberized and unlignified or only very slightly lignified.

The phelloderm is often fairly extensive. The outermost lavers consist of regularly arranged rectangular cells while the innermost cells are irregularly shaped and arranged. No sclereids appear to be present in the phelloderm. Latex cells, however, are frequent and are arranged in longitudinal rows of 2 to 10 cells with occasionally up to 14 cells in the line. They are usually elongated longitudinally but many are radially or tangentially elongated so that their radial or tangential measurement is greater than their longitudinal measurement. The walls are thin, suberised and unlignified. The cells measure R and T = 35 to 115*u* and sometimes up to 160, L = 30 to 150*u*. The latex is completely soluble in ether as well as in alcohol, solution of sodium or potassium hydroxide and solution chloral hydrate. It stains yellow with solution of iodine. (Figure 9A).

The phelloderm cells also contain cluster crystals of calcium oxalate scattered irregularly throughout the tissue with two or three crystals in a cell. They measure 5 to 37*u* in diameter. Some small prismatic crystals measuring 12 to 18*u* long are also present. (Figure 9D). All the cells of the phelloderm, except the latex cells and those containing crystals of calcium oxalate are full of starch grains. The grains are round, oval or semi-faceted in shape, the round and oval ones being single and the muller shaped ones being in aggregates of up to 10 components. The individual grains measure from 1.85 to

45.0*u* in diameter. The hilum is visible in the larger grains and is eccentrically placed. Striations are visible on some grains. (Figure 9E).

The remainder of the tissue external to the secondary cambium is secondary phloem which consists chiefly of small thin-walled parenchymatous cells filled with starch or with cluster crystals of calcium oxalate. Small groups of sieve tissue are also present and there are longitudinally arranged rows of latex cells. Phloem fibres are absent. In the zone nearest to the cambium the cells are rectangular in shape and regularly arranged in radial rows but farther away from the cambium this regularity is less apparent. In places the development of a uniseriate medullary ray may be seen but the rays rarely extend very far due to the formation of the large latex cells. The medullary ray cells are radially elongated and are larger than the phloem parenchyma, their sizes being R and L up to 28*u* and T up to 75*u*. They are not readily seen in tangential sections but can be seen in radial longitudinal sections as bands of cells 5 to 9 cells high. All the medullary cells are packed with starch. The small amount of sieve tissue is present in isolated groups of 5 to 12 sieve tubes especially near to the cambium.

Longitudinal sections show the sieve areas to be divided into groups, the sieve plate ends being obliquely arranged. The most prominent feature of the secondary phloem is the large number of latex cells arranged in a similar manner to those in the phelloderm except that there may be as many as 20 cells in a line. The starch and the crystals of calcium oxalate are similar in shape and size to those in the phelloderm except that the crystals are arranged in longitudinal rows of up to 35 crystals.

The secondary cambial zone consists of 3 to 5 rows of narrow rectangular cells slightly elongated tangentially. (Figure 8C).

The secondary xylem consists chiefly of parenchymatous cells which are produced in regular radial rows from the cambium. The cells are elongated radially; some are long and narrow and others quite wide but it is not possible to pick out, in any of the sections, whether any row could be considered as a medullary ray. The dimensions of the cells are R = 18 to 160*u*, T = 8 to 65*u* and L = 45 to 115*u*. All these cells are filled with starch similar to that in the phloem and phelloderm but there are no crystals of calcium oxalate. There are no latex cells in the xylem and nearer to the centre of the root the cells lose their regularity in shape and arrangement.

Lying adjacent to, and having been cut off from the secondary cambium on the inside, are the small scattered bundles of lignified tracheal elements. Similar groups of lignified elements are scattered throughout the entire xylem. They contain vessels, either singly or in groups of two or three. There may be 1 to 8 or even up to 12 vessels in a bundle. (Figure 8C). The vessels have thickened lignified walls the majority having oval or round bordered pits but some have elongated bordered pits and a few have scalariform-reticulate thickening. The vessel segments measure L = 100 to 275*u* and R = T = 25 to 15*u*. (Figure 10A). In addition to the vessels the bundles contain tracheidal fibres. The tracheidal vessels are very common and there

Figure 7. (Above) **TAMPICO JALAP** X 2/3.

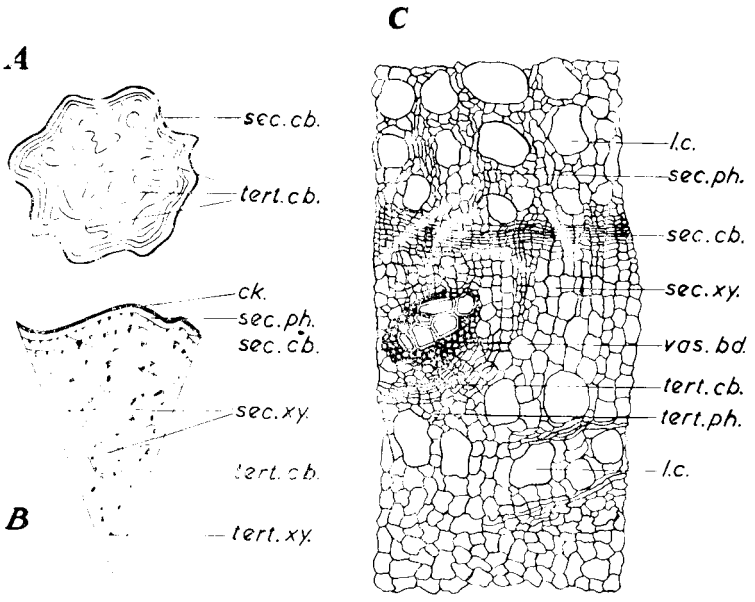

Figure 8. (Below)

A and B. Transverse surface of Tampico jalap showing typical pattern of secondary and tertiary cambia. A X 1. B X 2 to 3.

C. Transverse section of Tampico jalap showing secondary phloem and xylem X 60.

ck. cork; sec. ph. secondary phloem; sec. cb. secondary cambium; sec. xy. secondary xylem; tert. ph. tertiary phloem; tert. cb. tertiary cambium; tert. xy. tertiary xylem; l. c. latex cell; vas. bd. vascular bundle.

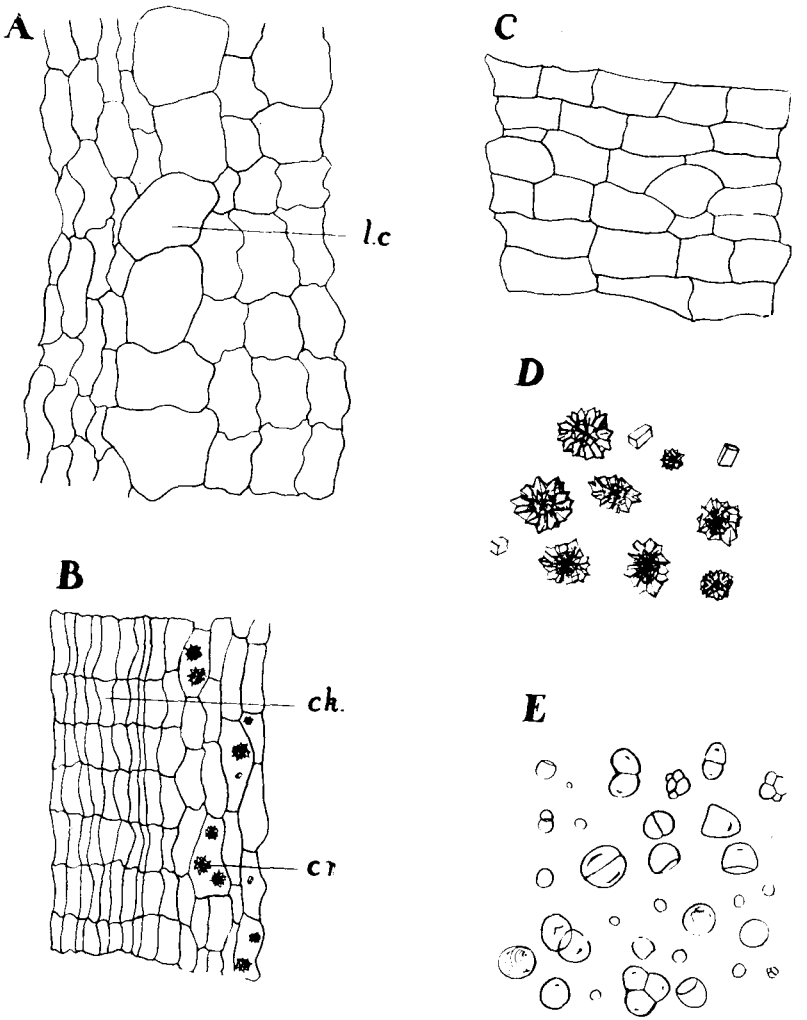

Figure 9. **TAMPICO JALAP.**

A. Latex cells (R. L. S.) X 120.

B. Cork and phelloderm (R. L. S.) X 80.

C. Cork (surface view) X 120.

D. Calcium oxalate X 180.

E. Starch X 180.

l. c. latex cells; ck. cork; cr. crystal of calcium oxalate.

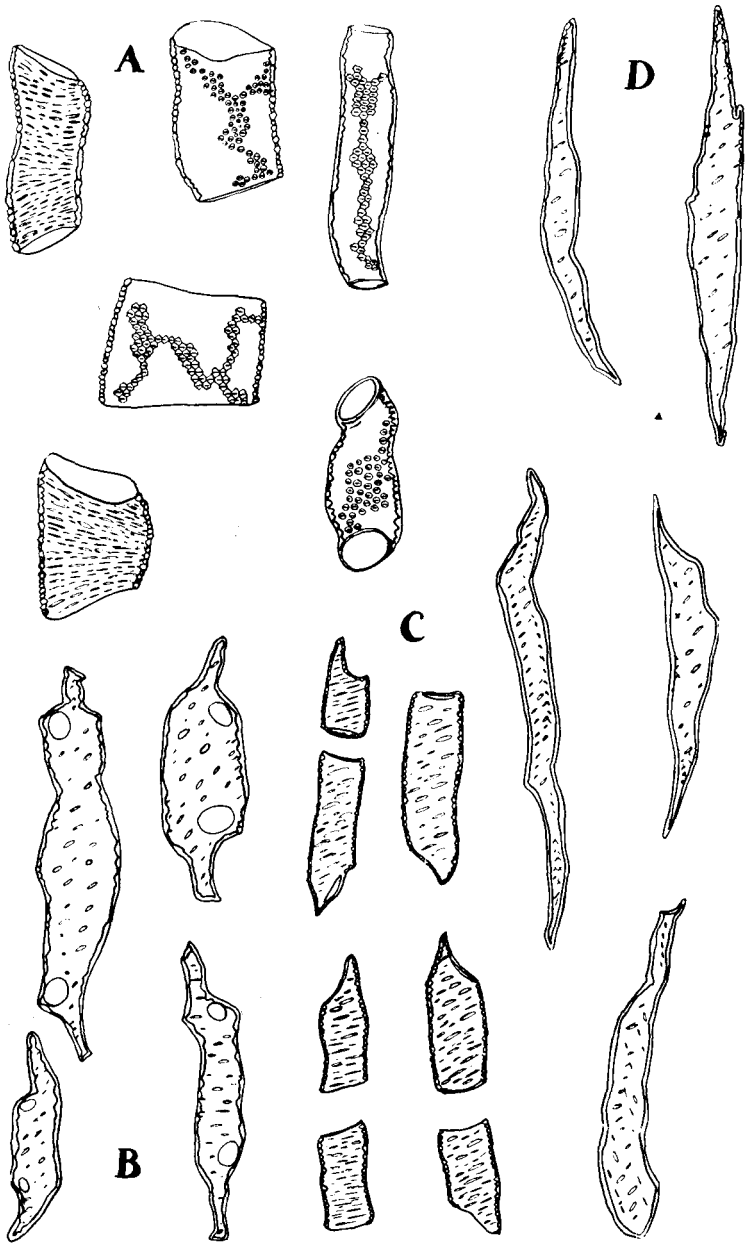

Figure 10. **ISOLATED LIGNIFIED ELEMENTS OF TAMPICO JALAP** X 120

A. Vessels.
B. Tracheidal vessels.
C. Tracheidal vessels.
D. Fibre tracheids.

are two types, one having two pores, one at each end of the cell on the inclined surface at the places of contact with the neighbouring tracheidal vessel and the others having a similar pore at one end only and a complete transverse perforation at the other. The former type are very characteristic in shape and have elongated bordered pits with oblique slits. They measure L = 200 to 400*u* and R = T = 25 to 80*u*. (Figure 10B). The second type look like small vessels and have elongated oval bordered pits. They measure L = 100 to 200*u* R = T = 40 to 65*u*. (Figure 10C). The few tracheids present measure L = 250 to 500*u* and R = T = 30 to 60*u* and have elongated bordered pits. The fibre tracheids have slightly thicker walls than the tracheids and tracheidal vessels and have oblique slit-like pits. They measure L = 300 to 650*u* and R = T = 25 to 50*u* (Figure 10D).

All the tertiary tissues are within the secondary tissues, the tertiary cambia being readily discernible in the xylem parenchyma. The tertiary cambia take forms which are similar to those found in Vera Cruz jalap. Groups of xylem elements which are obviously tertiary xylems are sometimes formed on the outside of the cambium and sometimes on the inside of the cambium. There are some groups of xylem which are near to the tertiary cambia but it is not possible to say with any certainty whether they are secondary or tertiary xylems. Histologically, the elements in these xylem groups are identical with those in the secondary xylem groups which are adjacent to the secondary cambium.

Tertiary phloem is always formed by a tertiary cambium on the side opposite to the xylem group and consists of thin-walled parenchyma and longitudinal rows of latex cells similar in size to those in the secondary phloem. Sieve tissue does not appear to be formed in the tertiary phloem.

Summary

The examination of Vera Cruz jalap and Tampico jalap confirms the similarity of the two drugs. Morphologically they can easily be distinguished by the appearance of their outer surface. Anatomically they are identical and histologically the only difference between them is one of size of the various cells and cell contents. In the powdered condition two features which may be used to distinguish between them are (1) the absence of stone cells in Tampico jalap but their presence in Vera Cruz jalap and (2) the maximum size of the crystals of calcium oxalate.

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FOOTNOTE

In recording the measurements, the system adopted by Moll and Janssonius (i. e. the dimensions on the radial {R}, tangential {T} and longitudinal {L} directions of growth) is used in the majority of cases for the sizes of cells. Where, however, this system might be confusing or ambiguous, the ordinary method of recording the longest and the shortest axes, irrespective of direction of growth is given.