however, was very slow in onset and of much longer duration. These experimental findings are in complete agreement with numerous clinical data gathered concerning this drug by the senior author.

SUMMARY

1. A new method for quantitative determination of pain threshold in experimental animals has been described.

2. The method consists of applying the faradic current from a standardized induction coil to certain sensitive areas of the scrotum of tame adult male rats and measuring in absolute physical units the minimal energy required to elicit a painful squeal, *i. e.*, the threshold of pain.

3. In complete agreement with clinical experience, a large number of drugs examined in this way were found to produce analgesia in the rat, a circumstance recommending use of this new method in research concerning the analgesia produced by unknown substances.

4. A large number of analgesic drugs (opiates, coal-tar derivatives, alkaloids, etc.), tested in this way, have yielded data running parallel to clinical experience with some medicaments in men.

5. The findings obtained by such a method in studying analgesia produced by morphine and cobra venom agree not only with those derived from studies on guinea pigs and on *normal* human subjects, but also with those obtained from numerous clinical reports.

6. The new method offers a useful and accurate means of detecting analgesic properties of new compounds on which investigative work has not progressed so far as to warrant a clinical trial on human subjects.

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A Pharmacognostical Study of Serenoa Serrulata (Saw Palmetto)*,†

*By B. V. Christensen‡ and R. C. Stokes***

COLLECTION

Information in the literature on the collection of Saw Palmetto berries is questionable and often contradictory. Statements have been made that the time of collection extends from August to January, or even rarely to March (5). Others say that the berries ripen in October and November and may be found until the middle of December (4). Questionable statements regarding the methods of collection are prevalent. For example, the United States Dispensatory (6) states that the fruits are gathered when fully mature, partially dried artificially and packed in barrels, and that, to the contents of each barrel, a small amount of alcohol is added as a preservative.

In order to learn more exactly the time of collection of the berries and to obtain accurate information concerning the methods of collection, several trips were made by the writers to localities in Florida from which the commercial supply of Saw Palmetto berries

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is at present obtained. These trips included visits to the east coastal region of Florida, from Daytona Beach south to New Smyrna, to Coronado Beach and to Canaveral Island (Cape Canaveral). By visiting these localities, by conversing with experienced collectors of Saw Palmetto berries and by observing the types of apparatus used in collecting and drying the berries, much valuable information was obtained. From this information, the writers present the following method of collection of Sabal berries. In their opinion, it is the one most commonly employed at present.

Time of Collection.—The berries are collected when they are full grown and ripe. Consequently, the time of collection varies, within limits, each year according to climatic variations. As a general rule, the time of collection begins as early as September 1, and continues until January 20. Berries gathered during mid-season (October 15 to December 20) appear to be of a better quality than those collected at other times. The early- and late-gathered berries seem to be deficient in oil and syrupy exudate. This deficiency of oil and syrupy exudate causes the berries to become hard and quite brittle after they are dried.

The fruits appear to be more abundant in alternate years. Sometimes, however, there may be several consecutive years in which few berries are produced. Following this scarcity, the fruits may be abundantly produced for several consecutive years. There appears to be no satisfactory explanation for this inconsistency of fruit production.

Procedure of Collection.—Experienced white collectors are employed for the collection of the fruits. The fruiting stalk, containing the ripe fruits, is cut with pruning shears. The stalk is then shaken over an ordinary bean hamper, the berries falling into the hamper (see Fig. 1). After the hampers are filled with berries, they are carried to a shed where the berries are transferred to trays for subsequent sun-drying.

Drying Procedure.—The berries are placed in lath-slatted drying trays. These trays are about three and one-half inches deep, three feet long and two feet wide. They are usually about half-filled with berries and then placed on inclined wooden benches or racks. These racks are so constructed that the trays rest on them at an angle of about 30 degrees.

In this position, the berries are allowed to dry in the sun for a period of six to eight weeks. During this drying process, care must be exercised to prevent the berries from becoming too moist from exposure to excessive rainfall. One or two rains aid the process by washing off the "syrupy" fluid which exudes from the berries during drying. More than one or two rains are injurious, resulting in molding and decaying. In order to protect the berries from too much moisture, tarpaulins are spread over the trays during the rains.

Fig. 1.—Fruiting Stalk of Sabal with Berries.

As the drying process continues, berries that have become thoroughly dried are removed from the trays by hand picking and fresh, undried berries added. The partially dried berries are placed at the bottom of the trays in order to give them greater protection from rains.

After the fruits have become thoroughly dried, they are removed from the trays and garbled (hand sorted). Those which are not well filled and whose surfaces are not creased or wrinkled are discarded and usually fed to animals. The good berries are placed in wooden or tin containers until ready for shipment.

The berries are not placed in brine or alcohol during the period of storing and shipping. In fact, no preservative is added. The fruits are shipped either in the fresh, ripe state, in the semi-moist state or in the dried condition.

The above method of collection is the one used today by conscientious collectors. However, there are many unscrupulous collectors of Saw Palmetto berries who make no attempt to follow this procedure. They collect berries which are still green; they have few, if any, trays or racks; and they make no attempt to garble the berries, but ship all fruits collected.

It appears that many firms who buy and use Saw Palmetto berries are not aware of differences in quality of the fruit. As a result, they are at the mercy of unscrupulous collectors.

HISTOLOGY

A review of the literature shows that little study has been devoted to the histology of the fruit and seed of Saw Palmetto. Also, microscopical studies of the powdered fruit and seed appear to be meager.

John M. Maisch (2) in 1883 published J. Moeller's description of the fruit and seed of this drug. This description is mostly macroscopic. His drawing of the pericarp is fairly accurate, but the few cells of the endosperm of the seed which are illustrated do not clearly represent this region.

Henry H. Rusby (5) in 1895 studied the structure of the fruit and seed of Saw Palmetto. His description is entirely macroscopic. This publication includes no drawings.

H. Kraemer (1) in 1910 made the most complete microscopical study of the fruit and seed that has been made up to the present. His description and drawing of the three outer rows of the fruit (which he calls epicarp) are accurate, but his drawing of the cells of the adjoining layers (which he terms sarcocarp) does not accurately represent this region; he describes these cells as being nearly isodiametric. Actually, these cells are of irregular shapes and sizes. His description of the cells of the inner layer of sarcocarp is much too brief, and he does not show them in his drawing. He mentions that sieve, cambium and spiral vessels constitute the fibrovascular bundles. No cambium cells were seen by the writers in the fibrovascular bundle. Kraemer reports the absence of rosette crystals of calcium oxalate; yet these were occasionally found by the writers to be present.

There are also discrepancies in Kraemer's drawing of the seed. The testa is not composed of one layer of thin-walled, tangentially elongated cells, but is made up of several layers of thin-walled, irregularly shaped cells. The cells of the endosperm are shown in his drawing as being radially elongated; in reality, those cells are of various shapes. Also, the canals in the walls of the endosperm cells appear to be occluded pores, more or less flared at their distal ends, rather than rounded, slightly tapering penetrations of protoplasm as they seem to be represented in Kraemer's illustration. His description of the seed is much too brief. He does not describe the seed coats or the cells of the perisperm.

The description in the United States Dispensatory (7) of 1937 is incomplete and without detail. The description of powdered Sabal in the National Formulary VI (3) is incomplete in that it does not include all of the elements found in the powdered fruit and seed. No mention is made of the elements comprising the epicarp, testa, tegmen, perisperm or of the fibrovascular bundles.

These few scattered descriptions comprise the available studies of the histology of the fruit, seed and powdered drug. From these, it is apparent that a complete, accurate study of the histology of the fruit, seed and powdered drug is needed. Therefore, this present investigation was undertaken.

Source of Material.—The fruits and seeds used in this study were obtained from plants growing on Canaveral Island or Cape Canaveral, Florida (see collection of fruits).

Method of Treating Material for Microscopical Examination.—Special methods of treatment had to be devised in order to render the fruit and seed suitable for sectioning. The seed had first to be removed from the pericarp, and then each treated separately and sectioned separately. This removal of the seed was accomplished by making a transverse incision around the middle portion of the fruit, removing one-half of the pericarp and then taking out the seed.

The seeds were softened by boiling in water for 24 hours and then treated with a 25 per cent solution of hydrofluoric acid for a week, after which they were thoroughly washed in water and then placed in a mixture of equal parts of 95 per cent alcohol and glycerin for a week or longer. The softened seeds were embedded in paraffin and transverse sections made of them by the use of a rotary microtome. The sections were cut approximately 15μ in thickness.

The fruit, with seed removed, was steamed on a water bath for two hours. The pericarp was then cut into longitudinal strips about one and one-half cm. long and one-half cm. wide. These strips were embedded in paraffin and transverse sections, 15μ

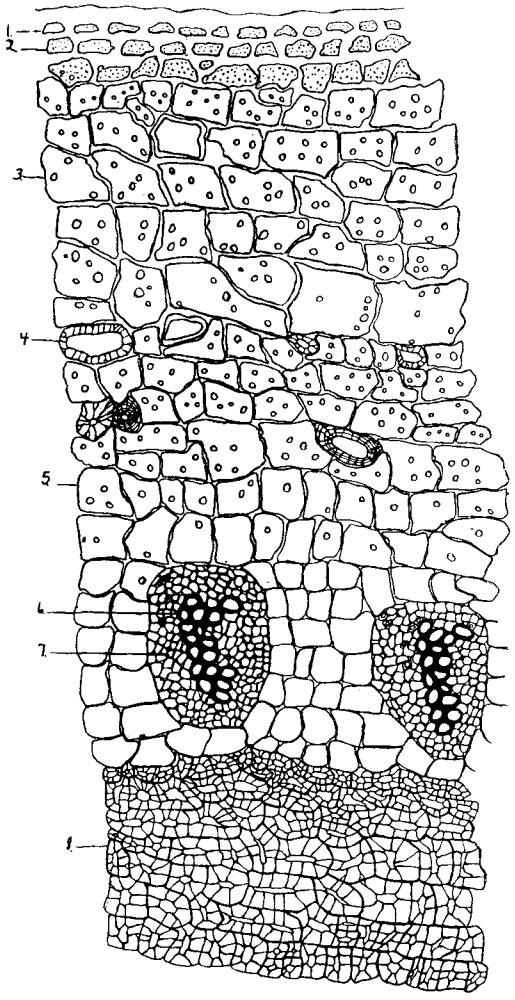

Fig. 2.—Transverse Section of the Fruit of *Serenoa Serrulata.*

in thickness, made of them by the use of a rotary microtome.

Transverse sections of embedded pericarp and seed were macerated in xylol for ten minutes in order to dissolve the paraffin. They were then treated for ten minutes with each of the following: xylol, absolute alcohol, 95 per cent alcohol, 75 per cent alcohol, 50 per cent alcohol and then placed in water. Various staining reagents were used for the purpose of more clearly differentiating the tissues. Those used were: safranin, Delafield's haematoxylin, phloroglucin hydrochloride, Bismarck brown, methylene blue, chlorozinc-iodine, alcanna tincture, sudan-glycerin, acetic acid, hydrochloric acid, 50 per cent sulfuric acid, 90 per cent alcohol, iodine water, chloral hydrate, 50 per cent glycerin, 5 per cent potassium hydroxide solution and concentrated potassium hydroxide solution.

After staining, the sections were examined under a compound microscope using low power magnification (100×) and high power magnification (440×). All drawings were made from high power magnification.

Method Used for Powdering the Material.—The fruits, with seeds removed, were placed in an electric oven at a temperature of 100° C. for twelve hours in order to remove any moisture present. They were then ground in a drug mill to a number 40 powder.

The seeds, after being removed from the pericarp, were thoroughly washed in water to remove the "syrupy" exudate adhering to them. They were then dried by placing in an electric oven at 100° C. for twelve hours. The seeds were ground to a number 40 powder by the use of a drug mill.

These powders were then placed in tightly closed bottles until ready for examination.

Description of Transverse Section of the Fruit.—(See Fig. 2.) The *epicarp* is composed of three regions: (1) *epidermis*, (2) *subepidermis* and (3) *inner epicarp region*. The **epidermis** (1) is composed of one layer of cells, the walls of which are strongly cutinized. The thick cuticle is of a straw color, and varies from 8 to 9μ in thickness. These epidermal cells are small, varying from 10 to 40μ in width and from 20 to 44μ in length. The shapes of their lumina are irregular, some being almost square, others rectangular to tangentially elongated and some in the form of an undulate triangle. The middle lamella of the cell wall is difficult to distinguish. These cells are filled with a yellowish to reddish brown amorphous substance.

The **subepidermis** (2) is composed of one to two layers of cells similar in appearance to those of the epidermis, but differing from them in not having their walls cutinized and being averagely of a larger size. The walls of these cells are of a cellulose nature. The width of these cells varies from 15 to 24μ; their length varies from 30 to 48μ.

The **inner epicarp region** (3) is composed of from 5 to 10 layers of cells containing a reddish amorphous material, which gives this region a distinct red appearance. The cells of this region show many variations in shape, but the majority of them are tangentially elongated; others are almost square, to round, to triangular in shape. These cells are much larger than those of the other two regions of the epicarp; their walls are also thickened. The length of these cells varies from 100 to 310μ, their width from 33 to 190μ. The majority of these cells contain one to several yellowish colored oil globules.

Interspersed among the cells of this region are occasional round to elongated, lignified[§] stone cells, some of which contain an orange colored amorphous material in their lumina. The size of these stone cells varies from 73 to 105μ in length and from 45 to 65μ in width. The thickness of their walls varies from 5 to 15μ. Striations and pores are not evident in these cells.

§ The term "lignified" as used in this and the following descriptions signifies a positive color reaction (some shade of pink to red) with acidified phloroglucin hydrochloride reagent.

The **mesocarp** (5) is the middle region of the pericarp. It is composed of 25 to 30 layers of cells, only some of which are shown in Fig. 2. These cells are also irregular in shape, some being tangentially elongated, others radially elongated, while those nearer the endocarp are usually approximately isodiametric in shape. These inner layers of the mesocarp, in which the fibrovascular bundles are located, are composed of smaller cells than those making up the outer layers of this region. The length of the cells of the outer layers of the mesocarp varies from 55 to 263μ; their width varies from 37 to 165μ. The cells of the outer region contain yellowish colored oil globules, but the cells of the inner layers appear to be devoid of them. The mesocarp cells do not contain reddish colored amorphous material such as is found in the epicarp cells.

Interspersed among the cells of the outer layers of the mesocarp are **lignified stone cells** (4). These stone cells appear to be of three types. Those of the first type have no evident pore canals or striations; those of the second type show no striations but have evident pore canals, some of which are branched; those of the third type have walls much thicker than those of the first and second types. These cells of the third type show both striations and pore canals, some of the latter being branched. The length of the stone cells varies from 33 to 189μ; their width varies from 20 to 137μ. The diameter of the lumen varies from 4 to 60μ. The thickness of their walls varies from 5 to 36μ. The shape of these stone cells varies from square, to round, to oval, to elongated.

The **fibrovascular bundles** (6 and 7) are located in the inner region of the mesocarp. These bundles are of the concentric type—phloem surrounding xylem. No cambium cells are evident. The xylem (6) occupies the central portion of the bundle, and is composed mostly of lignified, spiral vessels; few, if any, wood fibers are present. The phloem (7) surrounds the xylem, and is composed of sieve tubes, companion cells, phloem parenchyma and a few scattered bast fibers. Longitudinal and oblique views of fibrovascular bundles are occasionally seen; that is, some of the bundles appear to be running obliquely and at right angles to other bundles.

Intercellular air spaces are found throughout the mesocarp region. Most of these are small, some are fairly large. Occasionally, rosettes of calcium oxalate are seen in the cells of this region.

The **endocarp** (8) is composed entirely of strongly lignified stone cells having thick, porous walls. This region is composed of 7 to 12 layers of tightly fitting cells. These cells vary in shape from square, to round, to tangentially elongated; some are radially elongated. Their length varies from 15 to 46μ, their width from 15 to 45μ. All of these cells show evident pore canals, but few striations are evident. The walls of these stone cells are very thick (12 to 17μ); their lumina are small (5 to 10μ in width).

Description of Transverse Section of the Seed.—(See Fig. 3.) 1. **Testa.** This region is composed of 6 to 14 layers of irregularly shaped, tightly fitting cells, most of which are tangentially elongated. The walls of these cells are thick (4 to 12μ) and contain numerous pores. The walls of the outermost layers appear to be lignified. Many of these cells are filled with a reddish brown amorphous substance. The length of these cells varies from 11 to 225μ; their width varies from 8 to 80μ. These variations in the size of the cells were not evident in all of the sections examined. In some sections, this region appeared to be composed of cells of more or less uniform size; while in other sections extreme variations in sizes were noted. In sections where variations of sizes occurred, the smaller cells were located

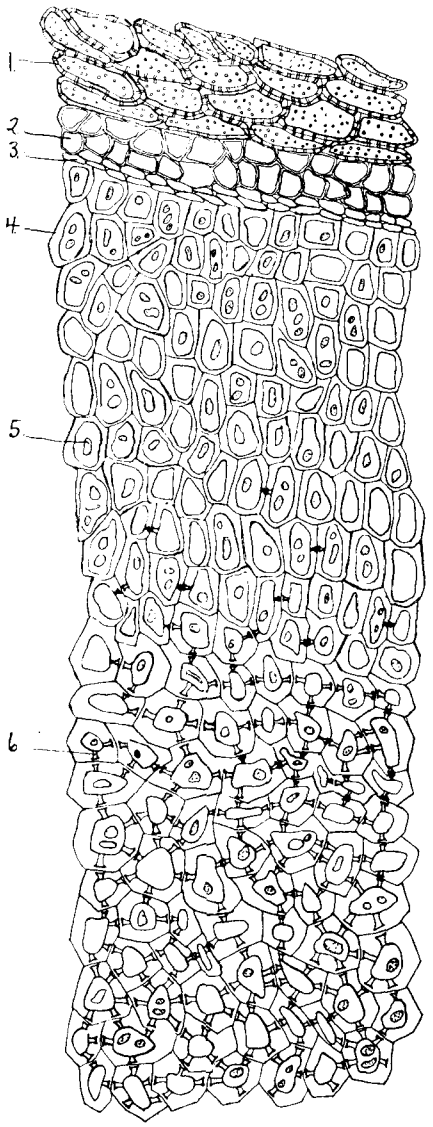

Fig. 3.—Transverse Section of the Seed of *Serenoa Serrulata*.

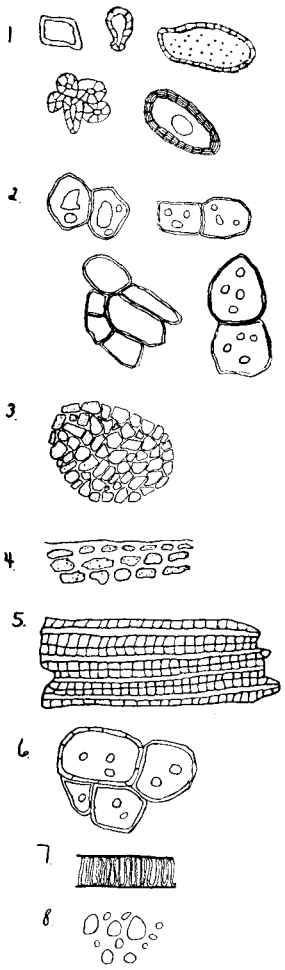

Fig. 4.—Elements of the Powdered Fruit of *Serenoa Serrulata*.

toward the periphery of this region and the larger cells toward the interior.

2. **Tegmen.** This region is composed of from 2 to 4 layers of cells. These cells are averagely considerably smaller than those of the testa (see Fig. 3). Their walls are thinner (2 to 4μ) and non-pitted. The length of these cells varies from 20 to 160μ, their width from 11 to 48μ. Their shapes vary from triangular, to square, to oblong to polygonal. These cells are arranged in an irregular fashion. They contain a yellowish to yellowish brown amorphous substance.

3. **Perisperm.** This region consists of 2 to 3 layers of thin-walled cells containing a straw to yellowish brown amorphous substance. These cells are smaller and more delicate than those of the tegmen. Their length varies from 18 to 32μ, their width from 5 to 12μ. They are usually tangentially elongated and have small intercellular air spaces. Sometimes the cells comprising this region are crushed and torn, and may be difficult to distinguish.

4. **Endosperm.** This region constitutes the largest portion of the seed. It is composed of many layers (40 to 50) of cells with thick, colorless walls. The cells comprising the outer layers of this region are somewhat radially elongated, but there is a gradual change in the shapes of the cells and a gradual increase in wall thickness as the center of the seed is approached. The cells comprising the middle portion of the endosperm are more elongated radially than the cells of the outer or inner layers. The innermost portion of the endosperm is composed of polygonal-shaped cells; their walls are also colorless and very thick. These cells of the central portion are characterized by striking canals in their walls (see 6 of Fig. 3). The distal ends of these pores are more or less flared and lie opposite similar pores of adjacent cells. The appearance of these canals would seem to indicate the probable presence of plasmodesma. However, close examination failed to reveal any such protoplasmic strands. These canals appeared to be occluded pores in the cell wall, rather than penetrations of protoplasm as apparently indicated by Kraemer's drawing (1). The cells of the endosperm vary in length from 20 to 148μ; their width varies from 20 to 45μ.

Many of these cells contain irregularly shaped, yellowish bodies; these are aleurone grains. An occasional oil globule was seen in a few of these cells.

Description of the Elements of the Powdered Fruit (Pericarp).—(See Fig. 4.) 1. **Stone Cells.** These cells are numerous and are found throughout the powder. Some of these occur as isolated cells, but the majority of them are found in groups. These stone cells appear to be of three types. Those of the first type are slightly lignified, have no evident pore canals and are nonstriated; those of the second type show no striations but have evident pore canals, some of which are branched; the cells of the third type show both striations and pore canals, some of the latter being branched. Stone cells of this third type are more numerous and their walls are thicker than those of the first and second types. Stone cells of the first type appear to be less strongly lignified than those of the second and third types.

Stone cells of the powdered fruit vary much in shape (see 1 of Fig. 4). They may be round, or oval, or ellipsoidal, or square, or spatulate or tabular. The size of these cells varies from 20 to 137μ in width and from 33 to 189μ in length. The thickness of their walls varies from 5 to 36μ, and the diameter of their lumina varies from 4 to 60μ. In the majority of stone cells the lumen appears to be empty, but occasionally an oil globule is found in the cavity.

2. **Cells of the Mesocarp.** These cells have somewhat thickened, colorless walls. The majority of the mesocarp cells contain a pale yellow to straw colored amorphous content. Many of them contain one to several oil globules. In shape, these cells vary from round, to square, to polygonal to oblong.

Their size varies from 37 to 165μ in width and from 55 to 363μ in length.

3. **Epidermal Cells as Seen in Surface View.** These cells are irregular in shape, varying from triangular, to square, to round, to oval, to polygonal to elongated. They have comparatively thick walls, but the middle lamella is difficult to differentiate. These cells contain a yellowish to reddish brown amorphous content. In size, they vary from 10 to 40μ in width and from 20 to 44μ in length.

4. **Fragment of Epicarp Showing Cells of Epidermis and Subepidermis.** The epidermis is composed of one layer of cells, the walls of which are heavily cutinized. The cuticle of these cells is of a straw color and varies from 8 to 9μ in thickness. These epidermal cells are small, varying from 10 to 40μ in width and from 20 to 44μ in length. The shapes of their lumina are irregular, as noted above, and they are filled with an amorphous content.

The subepidermis is composed of two layers of cells similar in appearance to those of the epidermis, but differing from them in not having their walls cutinized and in being averagely of a larger size. The width of these cells varies from 15 to 24μ, and their length varies from 30 to 48μ.

5. **Sclerenchyma Fibers.** These fibers are found in groups. They are usually lignified and their walls show many pore canals. Fibers are only occasionally found in the powder and then usually as broken fragments. They are very much elongated and have thick walls with narrow lumina. The thickness of their walls varies from 13 to 16μ; the widths of their lumina vary from 8 to 14μ. The lengths of these fibers are from 240 to 434μ; their widths are from 36 to 40μ.

6. **Cells of Inner Epicarp.** These are rather large cells with thick, colorless walls. Some of these cells have walls which are finely porous. Cells of the inner epicarp are filled with a reddish to reddish brown amorphous material. In shape, these cells vary from triangular, to round to elongated. Their length varies from 100 to 310μ; their width varies from 33 to 190μ. Many of these cells contain one to several yellowish colored oil globules.

7. **Fragment of Spiral Trachea.** Vessels are rarely found in the powdered fruit. They are slightly lignified with moderately thick walls. Only vessels of the spiral type are found in the powder. The tracheal fragment (as shown in 7 of Fig. 4) is 20μ in width and 76μ in length.

8. **Oil Globules.** These are found scattered throughout the powder; many of them are free and not located in cells. Their color varies from straw to pale yellow, and their size varies from 4 to 56μ in diameter.

The noteworthy elements of the powdered pericarp are the stone cells, the mesocarp cells and the cells of the inner epicarp.

Description of the Elements of the Powdered Seed.—(See Fig. 5.) 1. **Cells of Testa.** These cells are irregularly shaped, varying from square, to oblong, to triangular to elongated. The walls of these cells are comparatively thick (4 to 12μ) and usually contain numerous pores. Many of the cells have lignified walls, some showing heavy lignification, others showing only slight lignification, while a few show no lignification. There is a wide variation in the size of these cells; their length varies from 11 to 225μ, their width from 8 to 80μ. The widths of their lumina vary from 4 to 56μ. An occasional oil globule may be seen in the lumina of a few of these cells.

These cells of the outer seed coat are numerous, and are frequently found in groups scattered throughout the powder. Occasionally, isolated cells are seen. Many of the testa cells are filled with a reddish brown amorphous substance.

2. **Cells of Tegmen.** These cells are not as frequently seen as those of the testa. They are also averagely smaller than the cells of the outer seed coat and their walls are thinner (2 to 4μ) and nonpitted. However, a few of these tegmen cells appear reticulated in surface view (see 2 of Fig. 5).

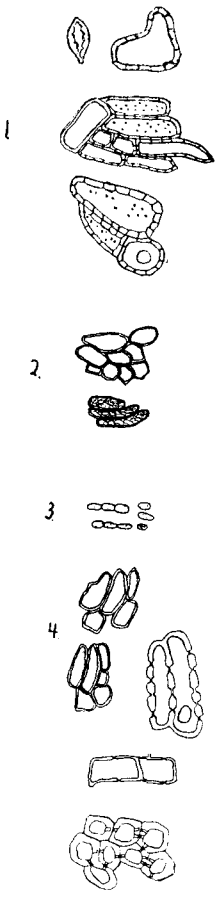

Fig. 5.—Elements of the powdered Seed of *Serenoa Serrulata.*

These cells are non-lignified, and they contain a yellowish to yellowish brown amorphous material. In shape, they vary from triangular, to square, to polygonal to oblong. They vary in length from 20 to 160μ and in width from 12 to 48μ. These cells are arranged in an irregular fashion as shown in 2 of Fig. 5.

3. **Cells of Perisperm.** These are delicate, small, thin-walled cells. Their length varies from 18 to 32μ and their width varies from 5 to 12μ. Their cell walls are only 1 to 2μ in thickness. In shape, these cells vary from oval to elongated. Very few of them are seen in the powdered seed, and usually they are found as broken fragments. The perisperm cells contain a yellowish to yellowish brown amorphous material.

4. **Cells of Endosperm.** These cells are more numerous than any of the other elements of the powdered seed. They are of various shapes and sizes. In shape, they may be square, or oval, or polygonal or elongated; in size, they vary from 20 to 45μ in width and from 20 to 148μ in length. Some of these cells have walls uniformly thickened; others have irregularly thickened walls; while still others show markedly thickened walls with large, characteristic pore canals (see 4 of Fig. 5). These cells have been previously described under the heading of the transverse section of the seed. These endosperm cells have thick walls, the thickness varying from 8 to 20μ. The width of their lumina varies from 14 to 30μ. Many of these cells contain yellowish colored, irregularly shaped aleurone grains; an occasional oil globule may be seen in some of these cells.

The most outstanding elements of the powdered seed are the testa cells and the endosperm cells.

SUMMARY AND CONCLUSIONS

1. The authors present a method of commercial collection of Saw Palmetto berries which, in their opinion, is the one most commonly employed at present. This method is based on knowledge obtained by visiting the actual localities where much of the commercial supply. of Saw Palmetto berries is collected, by conversing with experienced collectors and by observing the types of apparatus used in collecting and drying the berries.

2. An accurate study of the histology of the fruit and seed (both unground and ground) is presented. Drawings and descriptions of transverse sections of the fruit and seed and of the powdered fruit and seed are included in this study.

3. This histological study of Sabal shows that certain changes and additions should be made in the present monograph on Powdered Sabal of the National Formulary VI. The authors, therefore, recommend that this monograph be reworded and changed to read as follows:

"Powdered Sabal: Yellowish brown, fragments of inner epicarp, the cells containing a reddish to reddish brown amorphous material and yellowish colored oil globules; yellowish fragments of mesocarp, the cells having somewhat thickened colorless walls and containing a pale yellow to straw colored amorphous material and one to several oil globules; whitish fragments of endosperm numerous, the cell walls of which may or may not be uniformly thickened and usually showing large, characteristic pore canals; numerous stone cells, colorless to straw colored, varying in shape from tabular, to oval, to polygonal to elongated, from 0.020 mm. to 0.189 mm. in length, with walls from 0.005 mm. to 0.036 mm. in thickness, many of these cells showing numerous simple or branching pores and polarizing light with a distinct cross; occasional fragments of sclerenchyma fibers, having thickened walls and narrow lumina; fragments of spiral vessels only rarely present; straw to pale yellowish oil globules scattered throughout the powder, many of which are free and not located in cells; fragments of testa numerous, the cells usually containing a reddish to reddish brown amorphous substance; occasional fragments of tegmen, the cells having thin, non-pitted walls and containing a yellowish brown amorphous substance."

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