Anatomical Examinations of Selected Wood Species of Nigerian Genera in Anacardiaceae Family

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Article

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Abstract

Nigerian Anacarddiacea family was investigated in this study on the account of their inherent structures with a view to bringing to the fore those features that could facilitate identification towards proper utilization based on wood quality. Mature wood species of Lannea grandis, Lannea welwitchii, Mangifera indica, Nothospondis staudtia, Pseudospondias microcarpa, Sclerocarya burrea, Sorindeia trimeris, Spondias mangifera, Spondias mombin and Trichoscypha acuminate were got from the Forestry Research Institute of Nigeria herbaratum, in Ibadan. Wood samples from the wood species were sectioned into cross sectional, tangential and radial sections of about 20μm thick using a Reichert sliding microtome. Photomicrographs were taken using a digital camera mounted on a Reichert light microscope at 40 ×. The results showed that vessels were large in all the wood species except in Lannea species, Sclerocarya burrea, Nothospondis staudtia and Trichoscypha acuminata. Body ray cells were procumbent with one row of upright and/or square marginal cells in all the wood species, but could be up to four rows in Sorindeia trimeris. Generally, septate fibres, silica,crystals and gum were observed in almost all the wood species, yet, fibre pits in Mangifera indica, Nothospondis staudtia, Pseudospondias microcarpa, Sclerocarya burrea, Spondias mombin, and L. grandis were not as bordered as they were in L. acida, L. welwitchii, Sorindeia trimeris, Spondias mangifera, and Trichoscypha acuminata. S..mombin and S. mangifera can be separated on this account. It also appears that rays were storied only in Sorindeia trimeris and L. grandis. In the aspect of wood utilization, some were expected to possess fine texture, lustrous patterns and also regions of failures as a result of high rays.

Introduction

Distribution, arrangement and sizes of wood micro-features such as rays can be uniquely common among all the members of a family. Anatomically, some features have been observed as being typical of species belonging to the Anacardiaceae family (Royo et al, 2015). As a matter of fact, the presence of secre-tory structures has been reported as a common feature for members of the *Anacardiaceae* family; a feature that was also observed in *Spondias spp* leaves (Alex et al, 2016). Moreover, ducts associated with vascular tissue have been described in the stem (Venning, 1948) and the leaf of *Spondias dulcis* (Silva et al, 2000) in the *S. pinnata* leaf and in the stem of other species of *Anacardiaceae* such as *Anacardium spruceanum* (Paul and Alves, 1973), *Lithraea molleoides* (Carmello et al, 1995), *Schinus terebinthifolius* and *Mangifera indica.* The presence of calcium oxalate crystals was also described by Cronquist (1981) as a characteristic within individuals that belong to this family. In other tribes namely, Combreteae patterns of rays have also been reported as mostly uni-seriate, but sometimes 1–3(-more)-seriate (Vliet and Pieter, 1984). The unique feature of radial vessels is also entirely restricted to tribe Combreteae (Venning, 1948). It follows therefore that for every family there can be traces of definite pattern of arrangement, distribution and sizes of wood cells that are specifically restricted to the family. Anacardiaceae is generally considered to constitute about 70 genera and 600 species which are concentrated in the tropics of Africa, Asia and America with a smaller number of species occurring in subtropical and temperate areas. Plants in the Anacardiaceae family include trees, shrubs, woody climbers and perennial herbs. Different fruit trees of great economic importance for Brazil are within *Anacardiaceae* family. In Africa and South America are found 108 species restricted to these continents (Duvall, 2006), while four species of *Spondias* are economically important in tropical America, some representatives of the family in Nigeria are economically important, delivering products such as fruits and nuts (Metcalfe and Chalk, 1950; Cronquist, 1981). In traditional medicines, leaves from species within the family are used to treat some ailments such as inflammation and infectious conditions (Matos,2007; de Ciência,2010). The fruit species such as *Spondias*, *Anacardium occidentale* and *Mangifera indica* present social and economic importance due to the nutritional character of their fruits even in addition to their use in folk medicine. Of course, several attempts had been separately made in the past and in recent times on comparative anatomy of leaves and molecular phylogenetic studies on the Annonaceae family; such endeavours (Perre and Keey, 2014; Alex et al, 2016; Adeniran et al, 2020) studied foliar structures for their architecture while some keys were provided in other to substantiate the taxonomic relevance on the account of leaf anatomical features for species identification. Others like Badejo et al (2014).gave a summary of the anatomical features of the Nigerian Anacardiaceae, but this study is to further give details (in contrast to summary) of wood micro-structures in each wood species in the family. An attempt was also made in this study to bring to the fore the arrangement and distribution of vessels and rays that are peculiar to the *Anacardiaceae* family with a view to enhancing the process of wood identification.

Materials And Methods

Mature wood samples of about 1 cm x 1cm x 1cm cubes from species of *Lannea grandis*, *Lannea welwitchii*, *Mangifera indica*, *Nothospondis staudtia*, *Pseudospondias microcarpa*, *Sclerocarya burrea*, *Sorindeia trimeris*, *Spondias mangifera*, *Spondias mombin* and *Trichoscypha acuminate* were gotten from the herboratum of the Forestry Research Institute of Nigeria, Ibadan. Wood samples from the wood species were prepared into three planes namely cross sectional, tangential and radial sections of about 20μm thick using a Reichert sliding microtome. Sections were washed with distilled water and covered with safranin stain for ten minutes after which the sections were later washed with distilled water until the water became colourless. Dehydration was done by passing the wood sections through a series of bath of increasing concentrations of ethanol which replace. The specimens were later covered with vegetable oil[2] for 1 hour in order to drive off alcohol. The sections were placed on a clean slide, excess oil was drained off using filter paper; a slight amount of Canada balsam was added while the slide was covered with a glass and air bubbles were removed by applying heat gently. Photomicrographs were taken using a digital camera mounted on a Reichert light microscope at 40 ×. A digital camera on a light microscope was used to photograph anatomical features. Nomenclature and cell sizes were determined following microscopic terminology for hardwood identification (IAWA, 1989).

Results

Sections of wood species as revealed by the micrographs showed that Vessels were large in all the wood species (Figs. 1–11) except in *Lannea species*, *Sclerocarya burrea*, *Nothospondis staudtia* and

Trichoscypha acuminata. Vessels with pore pairs and radial multiples of 3 or more were present in all the wood species investigated, and about 3–6 in *Nothospondis,*. Pores were ring porous in *Antrocaryon micraster, Mangifera indica, Nothospondis, Pseudospondias microcarpa, Trichoscypha acuminata, Sclerocarya burrea* and *Spondias mombin*. Perforations were simple in all the species.

Axial Parenchyma cells were diffuse and scanty in *L. acida, L. grandis*, diffuse in uniseriate bands in *L. Welwitchii* and *Nothospondis staudtia* (also paratrachea, unilateral); vasicentric in *Mangifera indica*, *Pseudospondias microcarpa* (also unilatera) and *Sorindeia trimeris* (sometimes with broad sheath); scanty and unilateral in *Sclerocarya burrea*; diffuse in uniseriate bands (also paratrachea, scanty) in *Spondias mangifera* and *Spondias mombin* (also vasicentric and unilateral); vasicentric ,unilateral and diffuse in uniseriate bands in *Trichoscypha acuminata*.

In addition to this, body ray cells were procumbent with one row of upright and/or square marginal cells in all the wood species investigated; marginal cells can be up to four rows in *Sorindeia trimeris*. Rays were two to three or more cells wide in all the species but exclusively uniseriate in *Trichoscypha acuminata*; biseriate in *Pseudospondias microcarpa* and *Lannea acida.* Rays could be up to 1mm or more in *Lannea acida, Lannea welwitchii*, and *Nothospondis staudtia*. Storied in *Sorindeia trimeris*, *Lannea grandis*.

The fibres were with bordered pits at the radial section in *Lannea acida, Lannea welwitchii, Sorindeia trimeris, Spondias mangifera, Trichoscypha acuminata*, but also beaded at the tangential section in *Antrocaryon micraster*, septate in all except in *Mangifera indica, Nothospondis, Sorindeia trimeris, Spondias mangifera, Trichoscypha acuminata*.

As regards inclusions (Table 1), silica bodies were present in all the wood species except in *Pseudospondias microcarpa, Sclerocarya burrea, Sorindeia trimeris, Spondias mangifera* and *Spondias mombin*. In addition to this, crystals were found in *Lannea acida, Mangifera indica, Pseudospondias microcarpa, Sclerocarya burrea, Sorindeia trimeris* and *Spondias mangifera*.

Tyloses were present in *Spondias mangifera*, *Spondias mombin, Trichoscypha acuminata* and *Pseudospondias microcarpa*, but abundant in *Lannea grandis* and *Sorindeia trimeris* where it is sclerotic. Intercellular canals were present in *Lannea welwitchii, Pseudospondias microcarpa, Sorindeia trimeris, Spondias mangifera*, and *Spondias mombin*; while axial canals in tangential lines were observed in *Nothospondis*; latex tube present in *Lannea grandis*.

Table 1
Features in Wood Species

Taxa	Silica	Crystals	Gum/Deposits	Int..Canals	Tyloses	Septate Fibres
Antrocaryon micraster	+		++(r)			+
Lannea acida	+	+				+
Lannea grandis	+		++ (r,v)		++	++
Lannea welwitchii	+		+ (r)	+		+
Magnifera indica	+	+				
Nothospondis staudtia	+		+ (v)			
Pseudospondias microcarpa		+	+ (r)		+	++
Sclerocarya burrea		+	+ (r, v)			++
Sorindeia trimeris		++	+(r)	+	+++	
Spondias mangifera		+		+	+	
Spondias mombin				+	+	+
Trichoscypha acuminata	+		+++ (r)		+	+

Legend to character codes: **+** = present, **++** = abundant, +++ = more abundant.

Discussions

Generally, septate fibres, silica,crystals and gum were observed in almost all the wood species, yet, fibre pits in *Mangifera indica, Nothospondis staudtia, Pseudospondias microcarpa, Sclerocarya burrea, Spondias mombin*, and *L. grandis* were not as bordered as they were in *L. acida, L. welwitchii, Sorindeia trimeris, Spondias mangifera*, and *Trichoscypha acuminata.* As a matter of fact, *S. mombin* and *S. mangifera* can be separated on this account. It also appears that rays were storied only in *Sorindeia trimeris* and *L. grandis.* In wood utilization, this trait could bring out a particular 'figure' to their planks as storied rays are often of decorative value (Cutler et al, 2007) on the wood species they occur. The microscopic features observed in this study were also observed in the previous work of Brazier and franklin (1961). Although rhomboidal crystals had been recorded inside the rays of *Spondias mombin* L. by the previous work, this feature was not observed in this study in the same wood species.

On the aspect of wood utilization, presence of small pores in *L. species*, *Sclerocarya burrea*, *Nothospondis staudtia* and *Trichoscypha acuminata* indicates that the wood species are expected to possess fine texture bestowed upon such wood species on the basis of their small pores. Hence, Kukachika (1969) and Mendis et al (2019) referred to texture as the diameter of the pores which influenced the wood texture some of wood species like *Albizia lebbek* that was found to posses coarse surface as a result of its big pores (Kukachika (1969). Therefore difference in texture among wood species can be recorded as a result of the distribution of pore sizes. Ray heights in *Lannea acida, Lannea welwitchii*, and *Nothospondis staudtia* can produce an attractive and very lustrous pattern on the radial surfaces of the wood species when quartersawn as their rays can be sometimes more than 1 mm. Perhaps this attribute is responsible for the quality of *L. Acida* which had been found soft but hard enough and flexible to be used for small stools, utensils and bows (Brasier and Franklin, 1961). This attribute of high wood rays can, however, form regions of failures from end checks that usually occur in the wood on the end-grain during drying; this is because rays represent planes of weakness along which drying checks develop easily Kukachika (Perre and Keey, 2014). Although, this can be minimized by using high relative humidity or by end coating. The presence of tyloses in *S. mangifera*, *S. mombin, Trichoscypha acuminata* and *Pseudospondias microcarpa* suggests that their wood will pose some challenges during impregnation of wood preservative chemicals especially in *Lannea grandis* and *Sorindeia trimeris* in which tyloses are either abundant or sclerotic. This is true since tyloses act as plugs within hardwood species making wood less permeable and harder to treat with preservatives (Hillis, 1972; Mirand et al, 2009). Meanwhile, depending on the end use, the presence of tyloses may also be advantageous as they increase the durability of the wood (Meyer, 1967; Dickison, 2000), and makes woods particularly useful for liquid containers especially the wood of *Sorindeia trimeris* in which tyloses are sclerotic. During seasoning too, permeability can be low particularly in *Sorindeia trimeris* as a result of blockage by tyloses.

The presence of silica in *L. acida, Mangifera indica, Pseudospondias microcarpa, Sclerocarya burrea, Sorindeia trimeris* and *Spondias mangifera* can pose some level of difficulty during sawing as they can cause a rapid dulling of the cutting tool; though high silica content provides good protection against termites (Jozsa and Middleton, 1994). Other wood species without silica bodies contained crystals. This means that majority of the wood species in this family possessed silicon dioxide, and calcium oxalate in form of crystals: a compound reported as a characteristic within individuals that belong to this family (Cronquist, 1981; Alex et al, 2016).

Conclusion

The results from this study indicate that separation of wood species within this family can be made easy during wood identification process given the patterns of rays and vessels which vary among the wood species investigated. However, certain traits such as crystals and silicon; septate fibres and the body ray cells which were procumbent with one row of upright and/or square marginal were characteristic features of the wood species within the Anacardeacae family.

Significance Statement

This study discovers features that bring about variability of wood species in Anacardaecea family. These anatomical structures also influence the behavior of the resultant timbers in service. The study will certainly assist researchers and wood end users to identify which features are common to all the genera within the Anacardaceae family and which features to be looked for during the process of wood utilization.

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Figures

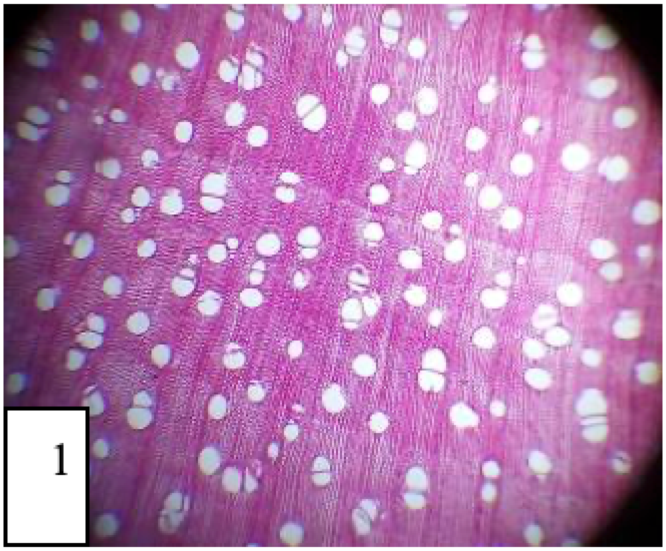

Figure 1

Transverse sections. - 1: *Lannea acida.*

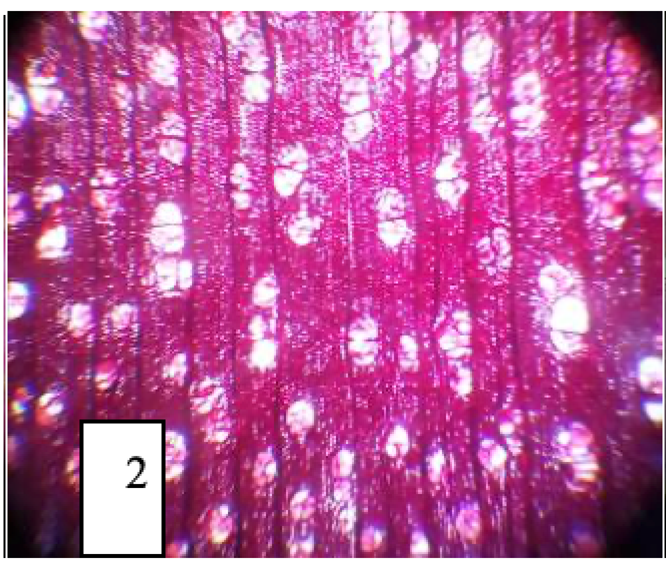

Figure 2

Transverse sections. 2: *Lannea grandis.*

Figure 3

Transverse sections. - 3: *Lannea welwitchii,*

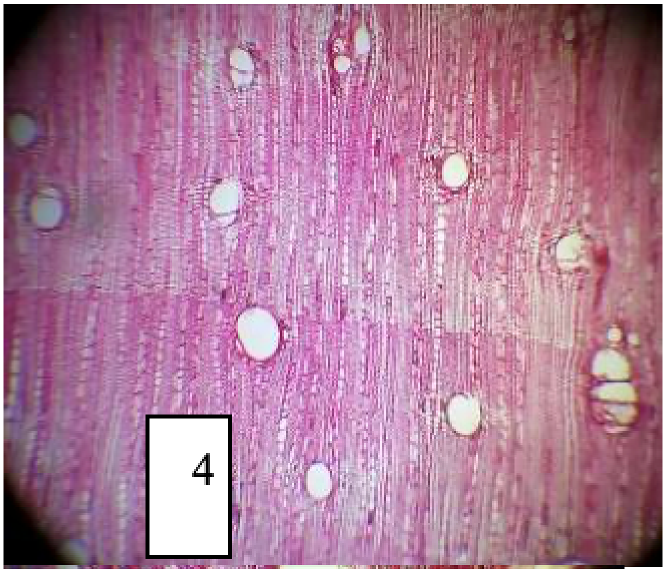

Figure 4

Transverse sections. - 4:*Mangifera indica*.

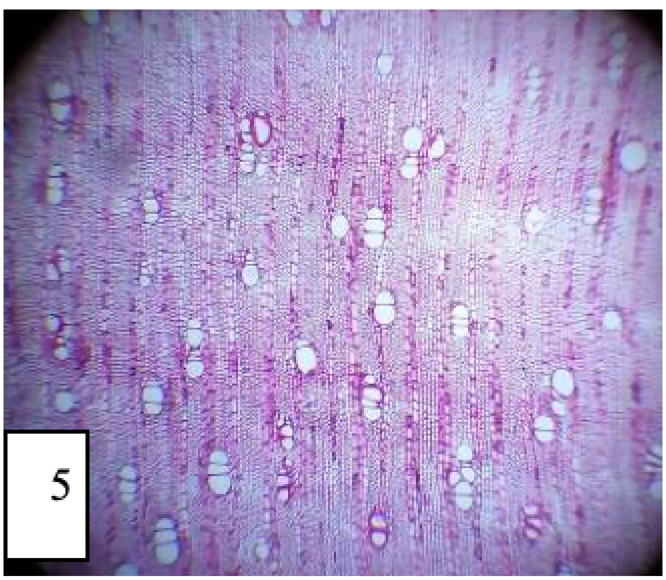

Figure 5

Transverse sections. - 5: *Nothospondis staudtia*.

Figure 6

Transverse sections. - 6: *Pseudospondias microcarpa*.

Figure 7

Transverse sections. - 7: *Sclerocarya burrea*.

Figure 8

Transverse sections. - 8: *Sorindeia trimeris.*

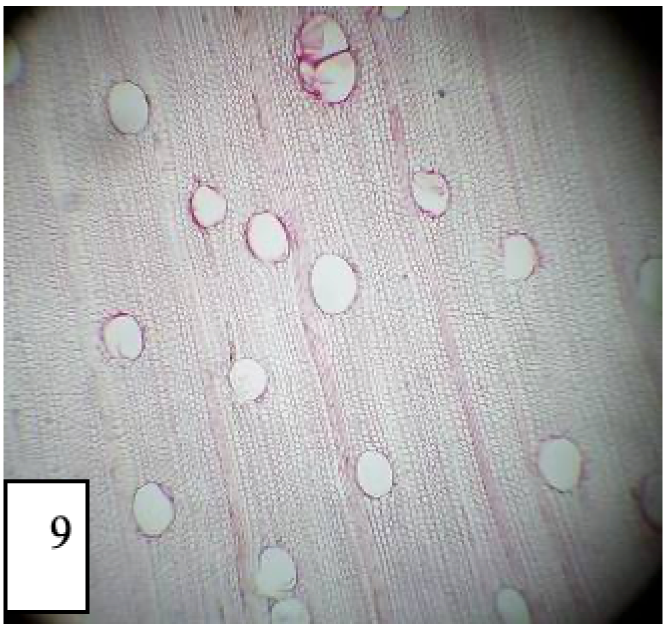

Figure 9

Transverse sections.- 9: *Spondias mangifera*.

Figure 10

Transverse sections. - 10: *Spondias mombin*.

Figure 11

Transverse sections. - 11: *Trichoscypha acuminata.*

Figure 12

Tangential longitudinal sections. - 12: *Lannea acida.*

Figure 13

Tangential longitudinal sections. - 13: *Lannea grandis*.

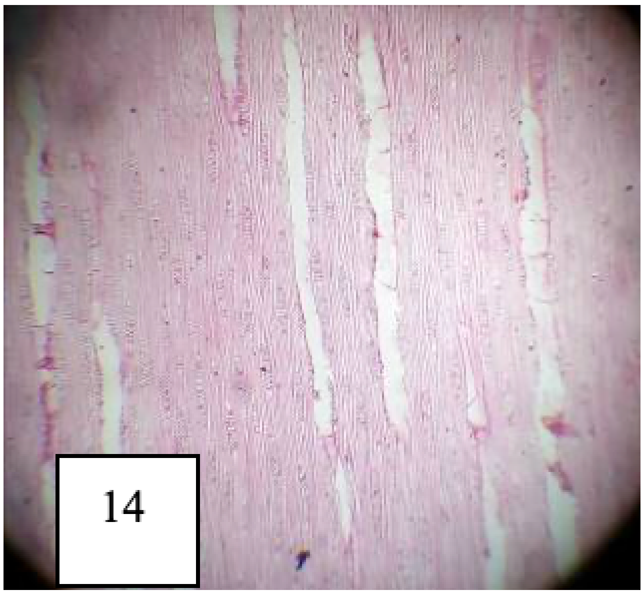

Figure 14

Tangential longitudinal sections. - 14: *Lannea welwitchii,*

Figure 15

Tangential longitudinal sections. - 15:*Mangifera indica*.

Figure 16

Tangential longitudinal sections. - 16: *Nothospondis staudtia*.

Figure 17

Tangential longitudinal sections. - 17: *Pseudospondias microcarpa*.

Figure 18

Tangential longitudinal sections. - 18: *Sclerocarya burrea*.

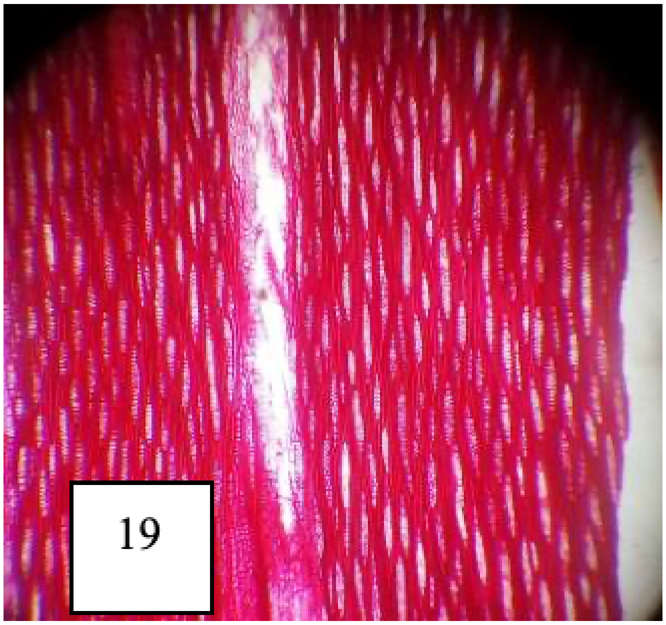

Figure 19

Tangential longitudinal sections. - 19: *Sorindeia trimeris.*

Figure 20

Tangential longitudinal sections. - 20: *Spondias mangifera*.

Figure 21

Tangential longitudinal sections. - 21: *Spondias mombin*.

Figure 22

Tangential longitudinal sections. - 22: *Trichoscypha acuminata.*

Figure 23

Radial longitudinal sections. - 23: *Lannea acida.*

Figure 24

Radial longitudinal sections. - 24: *Lannea grandis*.

Figure 25

Radial longitudinal sections. -25: *Lannea welwitchii,*

Figure 26

Radial longitudinal sections. - 26:*Mangifera indica*.

Figure 27

Radial longitudinal sections. - 27: *Nothospondis staudtia*.

Figure 28

Radial longitudinal sections. - 28: *Pseudospondias microcarpa*.

Figure 29

Radial longitudinal sections. - 29: *Sclerocarya burrea*.

Figure 30

Radial longitudinal sections. - 30: *Sorindeia trimeris.*

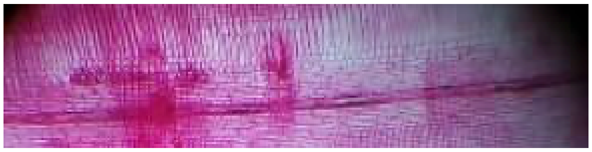

Figure 31

Radial longitudinal sections. - 31: *Spondias mangifera*.

Figure 32

Radial longitudinal sections. - 32: *Spondias mombin*.

Figure 33

Radial longitudinal sections. - 33: *Trichoscypha acuminata.*