INTRODUCTION

This study has been undertaken to better understand the anatomy of pith paper and the presentation needs of the unique cultural objects made of pith paper. In 19th century China, a new fusion of Chinese and Western painting techniques emerged in response to the diplomatic activities of Emperor Qianlong (1711–1799). These local innovations in painting held great appeal to the foreign merchant traders in China, and, more importantly, for their customers in Europe. 

By the early decades of the 19th century the artists at work in the port city of Canton (Guangzhou), as a consequence of the mercantile state of trade, adopted a local diaphanous material – pith paper (also known as rice paper) – to the new craft of export watercolour painting. (Fig 2)

European botanists were active in China in the 19th century, some of whom were commissioned by Sir Joseph Banks. When they examined rice paper they determined it was composed of pith cells not rice fibres. However, it took many decades to discover the origin of this accepted name

Tetrapanax papyrifer

European botanists had difficulty establishing the correct, scientific name for the pith paper plant. The Chinese name for the plant was Xiulan (H. K. Lo et al., 1977). However, this plant was not formally described or given a scientific name until 1859. The plant was first planted in Royal Botanic Gardens, Sydney, in 1857 and was later grown by the Chinese. Recent DNA sequencing data indicates the genus

Tetrapanax

is a member of the family Araliaceae. This study aims to verify the anatomy of pith paper. This is the verso/recto orientation (the surface that can be painted).

PITH PAPER STRUCTURE

Four physical parameters were measured on both old and new pith paper: cell size, thickness, porosity (calculated from MicroCT data) and colour (measured using an X-Rite 200QC Colorimeter). (Table 1)

Cell size

There is a significant difference in cell sizes between old and new pith paper (using t-tests 0.05 significance level). This likely represents normal biological variation within and between plants. (Fig. 5)

Thick paper is more likely to have a high porosity, which is one of the contributing factors in its translucency. In comparison, Whiteman No.1 filter paper had a measured porosity of 51%. The old paper (mid 1800s) was slightly more yellow and darker than new pith paper (ΔE > 50).

This represents a moderate yellowing (pith cells have little lignin) compared with printed books of similar age (∆E = 20 - 50).

OBSERVATIONS ON CELL WALLS

No signs of degradation were observed on the cell walls of old pith paper. Pith cell walls have two states: straight walls and undulated cell walls — which most likely occur as the pith paper dries. It has been observed that pith paper expands when wet — some of this expansion could be due to the straining of the undulated cell walls.

TEST SAMPLES

Sample preparation for join

• New pith paper was folded and torn along weakened edges

• A 2%w/v/methylcellulose was adhered to one edge and a butt joint was formed

• Light pressure was applied until dry.

• The join was imaged in the MicroCT.

Observations

MicroCT produces 517 slices through the thickness of the join. These slices were selected at different depths to show different combinations of adhesion points. (Fig. 4)

Overall adhesion along the join is achieved through an accumulation of small points of contact that occur within the depth of the pith paper. Other adhesives, including diluted wheat starch paste and 2w/v% Kcl glue, had similar results.

Sample preparation for lining

• Removable tissue was prepared from Berlin Tissue (Gangolf Ulbricht) (2g/m² Koso and Mitsutama fibre) 2w/v% Kcl glue in ethanol.

• Removable tissue was adhered with arterial, new pith paper was positioned over the lining and light pressure was applied until dry. (Fig. 9)

• Pith paper colour measurements before and after lining gave ΔE = 135

• (ΔE = 2 is commonly regarded as a minimal colour difference).

• Berlin Tissue porosity was measured as 87% air space.

PIGMENT

The samples (2 x 2 mm) were randomly selected from a set of small fragments that had drifted to the album gutter (Fig. 4). The pith paper can be viewed in three orientations. A sheet of pith paper can be cut directly from the dried inner stem (pith) of Tetrapanax papyrifera papyrifer through a simple process that keeps the cell wall structure intact. As it is the only paper-like material to be produced directly from the pith of a plant stem, it is therefore closer in structure to a herbaceous specimen than a fabricated sheet of paper.

MicroCT

Pith paper samples were imaged using a Xradia MicroCT-400 MicroCT, Projected X-ray images (1801 images) were captured with the sample rotated 0.2° between each image (with a total capture time of 17 hours).

• This is a non-destructive, non-staining imaging technique.

• All data sets <1000 images were captured with a resolution of 0.23µm.

TERMINOLOGY

In this paper, “orientation” will be used to describe the orientation of MicroCT images. This approach is designed to map the botanical orientation of the cylindrical stem onto the rectangular sheet of pith paper. A sheet of pith paper can be viewed in three orientations. (Fig. 4)

1. Periclinal tangential longitudinal

This is the normal orientation of the sheet (the surface that can be painted). The cells in this orientation are aligned in rows across the direction of stem growth.

• Periclinal orientation runs parallel to the main axis of the plant (the cells where growth takes place just under the bark).

• Tangential orientation does not pass through the centre of the stem.

• Longitudinal orientation is parallel to the stem direction.

2. Transverse orientation is at right angles to the stem direction.

3. Anticlinal radial longitudinal

Anticlinal orientation is at right angles to the meristematic zone.

Radial orientation is in the direction of the centre of the stem.

Longitudinal orientation is parallel to the stem.

P&D-4795-9/2016

References


