The Kunstkamera has in its collection twelve albums with rich red brocade silk covers which contain 115 brightly coloured images of an exotic land (fig. 1). The albums were brought back from China by Nicholas II of Russia when he travelled on a Grand Tour of the Orient in 1891 [1]. He later donated them along with other gifts and acquisitions from his journeys to the Ethnographic Museum in St. Petersburg [2]. The images in the albums are painted on “pith paper”, a fascinating and unusual support which can be found in collections spread all over Europe and America. The Kunstkamera albums are still complete and are in relatively good condition. However little has been done to investigate the nature of this material and how it degrades and many such paintings in other collections are often in a dangerously fragile condition.

An Art Made for Strangers

Pith paper or “rice paper”, as it has been erroneously called in West, is in fact a material obtained from *Tetrapanax Papyrifer* (fig. 2) a shrub which is native to Southern China and Taiwan. The plant has been cultivated for centuries in China and its pith was used primarily for the making of artificial flowers [3]. It is also still commonly used as a diuretic in traditional Chinese medicine. However, in the early years of 19th century Chinese painters began to adopt it for a new purpose, as a painting support for watercolour paintings. It appears that it was used only for paintings produced for Western visitors and traders. Initially, in the early years of the century, albums of pith paintings were brought back by merchants, seamen and sometimes diplomats as souvenirs of their visits to foreign land. The albums in the Kunstkamera were presented to the Crown Prince Nicholas when he visited a tea factory in Hangzhou which was one the largest suppliers of tea to Russia. The albums bear the seal of the tea company Molchanov, Pechatnov & Co. They are therefore an interesting example of paintings which were brought back directly from China by a significant personage.

Clunas [4] points out that export art occupies a space which is neither wholly Chinese nor wholly European. It was, as he puts it an art made for strangers and it is perhaps particularly significant that the use of pith paper as a painting support seems to have been limited to watercolours produced for these strangers. Paintings on pith are therefore the supreme example of this genre. By the end of 19th century paintings on pith dominated the Chinese export watercolour market. The earliest dated example of a painting on pith is from 1820s [5] and they continued to be produced into the early years of 20th century. Their production therefore spans a significant and dramatic period in the history of relations between China and the West. Chinese paintings on pith reflect a joint history of trade with China when the USA and many European countries including England, Holland, France, Denmark, Sweden, Austria and Spain were establishing trading links with China. Paintings on pith are subsequently to be found scattered in collections all over the Western world. Early trade with China was carried out mainly by large licensed monopoly companies such as the Honourable East India Company. By the mid century the commerce was dominated by business houses and free trade ruled. There was a gradual shift from tribute trade to treaty trade.
At the beginning of the century, Western visitors and traders were confined to the city of Canton (Guangzhou) by the single port trade policy of 1757. Western merchants could only deal with the "hong" merchants who were licensed by the Chinese government. After the Opium Wars and the 1842 Treaty of Nanjing, the first of the unequal treaties [6] between East Asian countries and Western powers, China was forced to allow foreigners into other trading ports and the island of Hong Kong was ceded to the British.

Reflecting these changes, painters on pith were initially based mainly in Canton but later in the century they gradually began to establish workshops in the treaty ports such as Hong Kong, Shanghai and even in Beijing. These artists rarely signed paintings and many are anonymous. However some albums contain labels or stamps identifying the name of the painter in whose workshop they were produced. Unfortunately paintings have often been removed from albums in the past and much information has been lost. Albums which are still complete such as those in the Kunstkamera about which we know something of their history are therefore significant. Although the masters of the painting studios have been referred to as rather shadowy figures [7], contemporary references [8] suggest that there were a considerable number of people involved in the production of paintings on pith. The Chinese Repository of 1835 indicated that there were some thirty shops where watercolours on pith could be purchased in the vicinity of the hongs [9]. Carl Crossman has identified over thirty-five named painters and S. Williams Wells [10] wrote that between two and three thousand hands were employed in the production of pith paintings. In 1844 it was noted that

In every artist's studio are to be found the paintings on what is called rice paper. This is very delicate and brittle, and nothing can exceed the splendour of the colours employed in representing the trades, occupations, life ceremonies, religions etc., of the Chinese, which all appear in perfect truth in these productions [11].

Although the perfect truth of these representations may be debatable and has been much discussed, the brilliance of the colours of these watercolours on pith cannot be denied. Often the same workshops produced oil paintings and many of the artists such as Sunqua are better known for their paintings on canvas. It must be noted that the workshop tradition was one of the division of labour. The painters who worked in these workshops were considered by the Chinese to be artisans. The copying and reproduction of the same images was usual practice. One technique for reproducing an outline on pith paper is described by S. William Wells.

An india-ink outline is first transferred by dampening and pressing it upon the paper, when the ink strikes off sufficiently to enable the workman to fill up the sketch: one outline will serve for limning several copies, and in large establishment the separate colours are laid on by different workmen.

There was also a tradition of freehand copying and the fidelity of copies produced by Chinese painters was much admired therefore the direct copying of images must not be discounted.

The subject matter of these paintings reflects the fact that they were intended to conjure up an exotic land. Popular subjects included the flora and fauna of China such as birds, flowers and insects; ceremonial and judicial scenes with figures in detailed and brilliantly coloured costumes; depictions of scenes from the Peking opera; scenes showing street sellers and performers; depictions of manufacturing industries such as silk, tea and rice and landscapes or port scenes showing in intricate detail various kinds of boats, barges and ships to be seen in China. The Kunstkamera albums are thus a good example of the genre, containing as they do most of the subjects listed above. An image from this series is illustrated in plate 1.

One important feature of the style of these paintings is a reflection of the fact that they were an export art aimed at a foreign market. To a large extent the Chinese painters adapted their style to suit Western tastes. Painters attempted to emulate the conventions of western art such as single-point perspective and suggestions of shadows may even be seen in some paintings. The traditional Chinese manner of representing distances where "higher up" indicates "further away" is often avoided. Another determining factor in the style was that sheets of pith were only available in relatively small sizes, the largest usually being around thirty by twenty centimetres. There is a great variation in the quality to be seen in these paintings. This is hardly surprising, given the large numbers that were produced in many different workshops. As well as differences in quality according to the workshop, the wide range of subject matter is also relevant. Clunas points out, for example, that flower and bird painting formed part of the native pictorial tradition and thus it is in paintings of natural history subjects that the skill of the painters is usually more apparent. It seems [12] that there was a decline in standard as the century progressed. Later in the century and at the beginning of the 20th century, the production of very basic images on very small pith sheets became more common, as opposed to the larger more detailed images produced for albums. These smaller paintings were often sold in glass-topped silk covered boxes.
Pith paper has also been referred to as the "gauze of the gods" [13] and the best sheets certainly are extremely delicate and fine. The Tetrapanax Papyrifer [14] trees were harvested in winter, the stems cut down usually in the third and fifth year of growth. In the seventh year, in the final harvesting the tree was cut down completely. The branches or stems at the time of harvesting were about two to three inches in diameter and approximately five or six foot long. After being harvested, these stems were cut into lengths of between twelve and eighteen inches. The shorter sections of stems were then soaked to soften the pith and make it easier to extract. This was done either by stripping off the bark with a knife or by using a wooden dowel or metal rod to force the pith out of the centre of the stem. Holding the rod against a solid surface the stem was pushed downward, thus forcing the pith out. Apparently this often produced a sound similar to the popping of a champagne cork. Afterwards the pith rods were dried naturally, sometimes being exposed to the sun for several days a procedure which supposedly prevented staining. Sometimes the still moist pith was placed inside a hollow section of bamboo culm to dry so that it dried straight and cylindrical. Some examples of some pith rods can be seen in fig. 3.

These rods were then sliced spirally from the outside inwards to produce long thin strips of pith in a similar manner to which wood veneer is produced. The long strips or "ribbons" produced were then cut into rectangular or square sheets. An example of the type of earthware tile and a knife used to slice the pith into sheets were given to Kew Gardens by John Reeves, a tea inspector in Canton and are still in the collection (fig. 4). The knives were surprisingly large and heavy for such a seemingly delicate procedure. The tiles usually had metal strips along the top and bottom edges. They are no longer present in the example shown but it is possible to see where they used to be. The pith rods were placed within these strips on the slab and the knife would be held on top of the metal strips so that the thickness of the metal strips determined the thickness of the pith sheets. To obtain thicker pith, the metal edgings could be packed with paper to increase their height.

The method of cutting is described by James W. Davidson, Consul for the USA in Formosa:

With the knife at the extreme right of the plate and its edge facing inward, the pith cylinder is placed lengthwise against the blade, and is given with the left hand a rolling movement backwards, while the knife, guided by the right hand, follows closely, and thus paring off along thin sheet. The operation requires considerable skill, and in the hands of an adept workman so quickly is it performed that it appears as though a roll of white ribbon was merely being unwound [15].

According to Alexander Hosie [16], who witnessed pith manufacture in Chongqing, Western China, the skill required to cut these sheets was such that pith sheets were “manufactured only at night, when the city is asleep and the makers not liable to be disturbed”. Poor cutting could cause uneven thickness or wrinkling and it is sometimes possible to see parallel marks in paintings where the knife has left slight indentations in the sheet during cutting.

Nothing was wasted, larger sheets of pith being used for paintings, smaller ones for the making of artificial flowers. The scraps were used as a medicine, as stuffing for pillows or in the bottom of coffins to soak up fluids. Paper sizes ranged upwards from three and a half inches (90 mm) square to the large sheets of about ten by twelve inches (250 × 300 mm). The cost of the sheets reflected the skill required to cut them, large sheets costing one and a half pence each, whereas the same sum would buy 100 smaller sheets of about 3 inches square [17]. Some smaller sheets can be seen in fig. 5.

Pith sheets have a characteristic soft, almost spongy surface and are somewhat translucent in nature. This translucency was exploited by the painters who adopted the technique of backpainting traditionally employed in painting on silk. This involved painting the back of the sheet in certain areas with opaque pigments such as lead white mixed with other pigments such as insect dyes or red lead. The technique was commonly used in the areas of the faces and hands, the details of the faces for example being painted on the front and it is very effective in adding an extra depth to these areas. The verso and recto of a painting is illustrated in figs. 6ab and the opaque pigment is visible particularly in the area of the face. Paintings on pith are often very brightly coloured with thickly applied paint and have a characteristic velvety texture in thickly painted areas. This was noted as early as 1837 when it was attributed to the absorption of moisture.

Rice-paper absorbs water and swells so as to present an elevation which continues after it becomes dry and gives to the drawing a velvety appearance and a relief which no other kind of paper produces [18].

However it seems more likely that this effect is the result of the thick application of paint which fills the hollow vacuoles of the cells and then sits on the surface of the sheet, producing a raised effect. In contrast, lighter washes and touches of colour seem to cling around the edges of the cells. The painting medium was the traditional animal glue and the pigments used appear to be traditional mineral and organic pigments with the occasional addition of more modern manufactured pigments [19].
Erroneous Use of the Term “Paper” for These Objects

Despite the fact that in many Western countries pith is referred to as rice paper, it is not in fact paper at all. The misnomer rice paper was probably applied to pith because when this unusual and unknown painting support first appeared in the West it was assumed that it was a paper-like product. The name continues to be used today. However, even in the nineteenth century, botanists were aware that this was incorrect and that the material was in fact a plant tissue. It is possible to find many articles in the botanical literature of the time discussing the search for the source of this mysterious plant tissue. It took some time before the “rice paper plant” was correctly identified as *Tetrapanax papyrifer* by James Hooker, the Director of Kew Gardens in London in 1852. The Economic Botany Collection at the Royal Botanic Gardens, Kew, London has many pith-related items which were sent back by diplomats and travellers who also became involved in this search. After several failed attempts, a few specimens of the plant itself were sent back successfully to England from China in 1850s, one of which flowered in Kew in 1855.

Although often referred to as an unusual type of paper, pith differs from conventional paper in both structure and chemical composition. Paper is a manufactured product in which the plant material used in its production undergoes considerable processing. In contrast sheets of pith were cut from the inner pith of the plant stem and were not subject to the same processing.

The structure of pith reflects its function in the plant. It consists of almost spherical plant cells with large vacuoles which serve to store water and nutrients. These parenchymatous cells need to be flexible to perform their function and are therefore single walled. When the pith cells are packed together they form a sort of honeycomb pattern.

In contrast, paper is normally manufactured using long and narrow cells or “fibres”. These have a structural function in the plant and have double walls ensuring that they are more rigid. In fact, what is termed a fibre in most papers is the cell wall of a single fibre element, usually obtained by the pulping or “disruption” of woody plant tissues. Most mass-produced modern papers are derived from wood pulp, although in the past and still today a wide range of plant fibres are used in paper making.

In the making of conventional paper the fibres are first dispersed, refined or processed and then reformed into “felted” sheets during the papermaking process. A sheet of paper can therefore be described as a network of interlocking fibres with a layered structure. The paper is held together by the physical entanglement of fibres and hydrogen bonding between the fibres. In contrast, a sheet of pith or rice paper is essentially a thin section through a whole plant tissue. It is possible to see the lines of empty parenchymatous cells on the surface of the sheet under magnification (fig. 7).

The chemical composition of plant cell walls also varies according to the type of cell. This is significant because, as previously stated, the parenchymatous cells of pith have only single primary walls which do not usually contain lignin, although they do contain hemicelluloses and pectins. The secondary walls of the structural sclerenchyma fibres used for papermaking on the other hand often contain lignin. However the chemical treatments used in papermaking tend to reduce the percentage of lignin, hemicelluloses and extractives and increase that of cellulose.

Paintings on pith present the paper conservator with problems similar to those of paintings on conventional paper. Mechanical damage is however one of the most common problems posed by pith because of its tendency to split, often in almost straight lines. Sheets of pith have little folding endurance and split easily, becoming more brittle on ageing. This is often made worse by the careless mounting of paintings in albums. The paintings are held in place by small dabs of glue at the corners and by strips of silk around the edges of the paintings which are adhered to the album pages. However, the glue and strips were not always applied carefully enough and the paintings often slip and catch on the strips, causing more splitting. Even in albums which have been carefully handled such as those in the Kunstkamera, many paintings show severe losses and tears or “splits” (plate 2). The soft surface of paintings is also very easily damaged even by the touch of a fingernail.

Many pith paintings show the discolouration and the development of brown stains or “foxing” which is a feature often also seen in aged paper. This is not surprising as both materials are essentially cellulose based. Conservators have been reluctant to apply the aqueous methods used to treat discoloured or distorted paper to paintings on pith because of reports of the extreme expansion and contraction of pith on wetting and subsequent drying [20]. Equally significant is the fact that immersion in water or alkaline solutions could result in the loss of deteriorated hemicelluloses and pectins and consequent weakening of tissue integrity. Pith absorbs water readily and tends to curl up when wetted almost as if it is trying to regain the shape it had in the plant. However damp pith is very flexible and can be moulded into shapes which it retains on drying. It is therefore well suited to its traditional use in the manufacture of paper flowers. The humidification and pressing of pith sheets can be particularly damaging if not undertaken with care as the characteristic softness or spongy quality of the sheet can easily be lost.

No published work has dealt with the degradation of pith paper or the influence of artists’ media on pith paper both of which are paramount to this project. There has been little analysis of pigments on pith paintings apart from testing paintings as part of student projects [21]. There has been no attempt to obtain an overall idea of the pigments used in particular workshops or at specific dates.

Analysis of pith paper deterioration products in historic fragments and modern mock ups will aid in the comprehension of the mechanisms and the rate of the deterioration in both the pith paper and the media.
A better understanding of these mechanisms will benefit conservators and conservation scientists generally. It would be of great benefit if the following research questions could be answered:

What is the polysaccharide composition of pith paper from Tetrapanax Papyrifera?

What media have been used for the images and inscriptions in a number of works of art representative of Chinese works on pith paper supports and how can these be identified?

What deterioration processes take place in the pith paper support and how might these be influenced by the painting materials used?

How can the material be stabilized? What existing methods might be appropriate and what new approaches might be required?

What recommendations for future preventive care of collections of works of art on pith paper can be determined?

What recommendations can we make for the interventional conservation strategy for works of art on pith paper from Asia?

The conservation of pith paper has presented a problem for conservators although suggestions have been made for the interventional care of these objects. A comprehensive study of this problem and the formulation of conservation care plans based on a scientific investigation of the degradation of this material are long overdue. There is also a need for the production of a manual for the conservation of works on pith. Thus a research proposal is being formulated, by the authors, which aims to answer the above research questions. A joint multi-disciplinary project is envisaged which would bring together the skills and knowledge of practical conservation practitioners, biologists, paper physicists and chemists and benefit from the sharing of equipment and expertise in different academic institutions.

Notes

6. So called by the Chinese because they were the result of military power and nothing was given in return for the concessions agreed by the Chinese government.
7. Clunas, op. cit.
11. O. Tiffany Jr., The Canton Chinese, or the American's Sojourn in the Celestial Empire (Boston — Cambridge, 1849).
12. See M. Nesbitt, R. Prosser, I. Williams, “Rice-paper plant — Tetrapanax Papyrifera”, The ‘Gauze of the Gods’ and its products’, Curtis's Botanical Magazine XXVII/1 (2010). The artificial flowers may have been produced in the Tsin Dynasty, 1500 years ago, but Tsai (op. cit.) suggests that mass production probably did not begin until the Ming Dynasty (AD 1368—1662).
16. A. Hosie, Three Years in Western China (London, 1890).
Illustrations

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Fig. 3. Pith rods. Courtesy of the Economic Botany Collection, the Royal Botanic Gardens, Kew London.
Fig. 4. Earthenware cutting tile and knife. Courtesy of the EBC, Royal Botanic Gardens, Kew, London.
Fig. 5. Pith sheets. Courtesy of the Economic Botany Collection, the Royal Botanic Gardens, Kew London.
Figs. 6ab. Door Guardian. China, 19th century. Watercolour on pith. Private collection. Photo by R. Prosser. The recto (a) and verso (b) showing the technique of backpainting.
Fig. 7. Scanning electron micrograph of the surface of pith ×50. Courtesy of the David Randall, the Jeol Nanocentre, the University of York, England.