Restorative fashion: collaborative research, benign design and the healing powers of the *mutuba* tree

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A multidisciplinary group of researchers, artists, environmentalists and fashion practitioners in the UK and Uganda is investigating the full potential of a radically indigenous and endangered textile: Ugandan bark cloth, produced from the *mutuba* tree and part of the Intangible Cultural Heritage of Humanity. Our research methods include fieldwork in Uganda; natural dye experiments; the formulation of a biophilic design strategy; textile laboratory testing of strength, wear, water resistance and abrasion resistance, drape, shape and fit; and scientific laboratory testing of the unique antimicrobial properties of bark cloth.

Through this research we have uncovered important knowledge that may provide significant benefits to medical science; the central role of the *mutuba* tree in restorative, agroforestry systems; have created natural dyes that may confer bark cloth's properties to other materials; and have demonstrated its potential as a truly restorative, slow fashion textile through the creation of a series of luxury fashion garments.

Keywords: **bark cloth; wellbeing; antimicrobial textiles; indigenous knowledge; fashion research; biophilic design**.

Introduction

Stress, anxiety and depression accounted for around 55% of employee ill health and absenteeism in Great Britain in 2020 (Health and Safety Executive 2020). The World Health Organization (2019) has called for preventative strategies to be devised that improve physical and mental wellbeing and resilience, describing stress as the epidemic of the 21st century (WHO 2019). Spending time in nature is a luxury that many city dwellers find difficult to accommodate in busy lives, but research shows that the potential benefits of this to health and wellbeing are significant: walking in forests has a restorative effect on people suffering from a range of mental health disorders – including stress and anxiety - and has even been shown to boost the immune system (Kellert *et al* 2008; Bell and Ward Thompson 2014; Hansen *et al* 2017). Calm is improved and blood pressure decreased merely by touching the leaves and the bark of trees (Putra et al 2018, Morikawa et al 1998), so what if we were to actually wrap ourselves in the bark of trees? How might this impact our health and wellbeing? How might

fashion and medical science collaborate, with distant communities, to develop garments and other products that will be beneficial to the health of peoples and planet?

A group of researchers, scientists, artists, environmentalists, farmers and fashion practitioners in the UK and Uganda holistically is investigating, analyzing and developing the full potential of a radically indigenous and endangered textile: Ugandan bark cloth, produced from the *mutuba* tree (*Ficus natalensis*), considered a Masterpiece of the Intangible Cultural Heritage of Humanity (Nakazibwe 2005; Rwawiire and Tomkova 2013; UNESCO 2006). The Bark Cloth Research Network was formed in 2016, with an initial membership of fashion and textiles researcher and design-maker Dr Kirsten Scott, embroiderer and natural dye researcher Karen Spurgin and luxury branding specialist Mevin Murden from Istituto Marangoni London, and textile technologist Dr Prabhuraj Venkatraman from Manchester Metropolitan University (UK), to explore the potential of bark cloth in sustainable luxury fashion. The scope of the project has expanded since to become increasingly multi-disciplinary and international as new potentialities have emerged: our research team now includes microbiologist Dr Jonathan Butler from Manchester Metropolitan University (UK) and other network members include Uganda-based artist and environmentalist Fred Mutebi and agroforestry expert Stephen Kamya, as well as U.S. textile researcher and Fulbright Specialist Lesli Robertson. We use our diverse lenses, resources and skill-sets to examine, analyze, test, explore, experiment, manipulate, weave, applique, dye, coat, reinforce, shape, design with and stitch bark cloth, towards an understanding of what it is, what it might mean for restorative fashion systems, for indigenous textile traditions and for the communities that they belong to.

To date, through this research, we have explored ways to create garments and other products from a tree-based textile (made in its traditional way) that are not only carbon-negative but that also may have positive effects on human health and wellbeing and have uncovered some of the specific properties of bark cloth that contribute to this. In addition, the research has prompted more philosophical questions about what luxury really means today, in the Anthropocene, when traditional luxury values such as rarity, quality and longevity have been devalued by their ubiquity and participation in short-lived trends, thus becoming a key enabler of rampant consumerism (Scott 2019). We ask whether a sense of wellbeing - through connection to nature and to distant communities – is a true 21st century luxury and investigate speculatively the role that fashion research may play in facilitating this.

Different voices have contributed to this article that reflect their personalities and disciplinary conventions, so the tone and emphasis will vary from section to section: from the more objective, measured voices of the sciences to the more subjective, expressive voices of

the arts. We believe that the diversity of our research team is a strength, enabling us to gain new insights from one another and to consider the implications of these holistically.

The project argues, therefore, the importance of forming healthy, diverse research ecosystems that work collaboratively across disciplinary and geographical boundaries to support a future where the whole Earth community may thrive.

Ugandan bark cloth

Ugandan bark cloth is a non-woven, fibrous textile that has been produced by the Baganda of southwestern Uganda since at least the thirteenth century (Rwawiire and Tomkova 2013). Bark cloth is deeply tied to Baganda identity and tradition, as a signifier of status, culture and beliefs; originally worn only by the royal family and important chiefs (Nakazibwe 2005) before becoming more widely adopted as clothing in the area. Bark cloth was traded across central and east Africa for centuries, becoming an item of local and regional economic importance before its market, status and ultimately its production were undermined by the import of woven textiles by Swahili-Arab traders in the mid 1800s and later by the British (Nakazibwe 2005; Trowell and Waschmann 1953). Successive political and economic issues have impacted on the viability of bark cloth production - which was even prohibited in the 1970s and 1980s to suppress Baganda culture (Rwawiire and Tomkova 2014); as a result, the number of expert makers has diminished and the craft itself is at risk.

While bark cloth is still worn for ceremonial occasions by the Kabaka (king) of Buganda and by patriotic Bagandans for special events, it has had multiple other practical uses: including for interiors as wall coverings, storage, bedding, mats and partitions. Today, it is commonly used in religious rituals relating to death: a curtain of bark cloth both symbolically and physically separates the living from the dead in the royal tombs, for example; it is used to wrap the bodies of the deceased: up to fifty cloths may be wrapped around people of higher social status for burial, to ensure that they travel with dignity to the next world; and it is still used frequently in local witchcraft (Nakazibwe 2005). These negative associations have become an obstacle to it being worn by many young Ugandans and some faith communities, although some local artists and designers have tried to promote it in recent years. In addition to its problematic local connotations, bark cloth presents some significant material challenges, such as wear resistance, water permeability and tear strength.

Aims and objectives

An initial aim of this project was to reposition bark cloth as an environmentally friendly textile for the luxury fashion market: luxury not only being a highly influential, persuasive space for material and design innovation, but also associated with price points that might accommodate the research and development required to realize bark cloth's physical and aesthetic potential and which might accommodate truly fair pay for its makers in Uganda (Chappe and Lawson, 2020). The amount of time and expertise required to make a sheet of bark cloth is not reflected currently in its cost and the market is small. It was hoped that the research outcomes would improve the market for this important cultural cloth and therefore incentivize a generation of rural youth to learn the knowledge and skills required before they are lost with an ageing generation of master bark cloth makers or *bakomazi*. While this is still central to our project aims, the research has also provided a lens through which to discover unforeseen and significant additional benefits to bark cloth that offer the potential to improve human and environmental health and wellbeing through a number of different aspects.

Our project objectives include: to identify, test, establish and find applications for the beneficial properties of bark cloth to support human health; to raise awareness of the current plight of this rare and endangered material; to define its benefits as part of local agroforestry and ethnomedicine systems; to develop strategies for improving its strength and versatility; to develop natural dyes and finishes that are able to sustainably alter the appearance of bark cloth; to develop natural dyes from bark cloth itself that incorporate its beneficial properties; to develop a design strategy that is compatible with the challenges presented by bark cloth's specific materiality; to assess the benefits to health and wellbeing from wearing bark cloth; explore other potential applications; and to sustainably improve its market. You will notice that the word *benefit* or *beneficial* appears frequently in this article: we believe this to be a crucial characteristic that must be assessed when searching for new natural and restorative materials that proactively support a responsible future, and thus offers a distinct counter-narrative to the extractive and exploitative systems more commonly associated with fashion (Fletcher and Tham, 2019).

Methodology

Our research methodology is dynamic and pragmatic; it traverses the fields of anthropology, ecology, botany, agroforestry, microbiology, health, architecture, engineering, textiles history, textiles technology, art, craft, fashion design and luxury studies. Our methods include a continuously looping engagement with multi-disciplinary literature (that feeds into practice and vice versa); fieldwork in Uganda; observation; interviews; and laboratory testing; and

object-based research. However, the critical significance of our explorative, creative practice cannot be overstated in propelling this project forward and outwards, as 'thinking through making' (Ingold 2013:xi) and discussions with local actors have unlocked new ways of conceiving luxury that challenge the status quo and offer insights for a future where we all might thrive, as well as more immediately practical strategies and applications. New potentialities continue to emerge that underline the importance of this fluid and responsive research and design methodology, that requires us to step outside of our own disciplinary territories and the need for collaboration with those from others.

Through this research, we employ the metaphor of *borrowing* in an attempt to acknowledge and navigate the ethical complexities of working with the cultural heritage of other communities. Consultation with Ugandan team members and sharing with them knowledge as it is generated are considered key. Using this metaphor of *borrowing*, the bark cloth will be *returned* to its community with *interest*, in the form of the new knowledge generated, improved market awareness, and recommendations that we hope will be beneficial to local and global communities. We suggest that our 'borrowed cloth' model represents a responsible, non-exploitative approach to interventions of this nature - when working with the cultural property of others - that may be transferrable to other geographical or disciplinary contexts, although we acknowledge that we must keep refining this and keep listening to other voices.

Bark cloth making in Bukomansimbi

Bark cloth making is a highly skilled, gendered craft, passed down through generations of men and is entirely aligned with responsible stewardship of the land. Paul Bukenya Katamiira and Vincent Kajooga – from the Bukomansimbi Organic Tree Farmers (BOTFA) group – are ninth generation *bakomazi*; they told us that their families have been tending *mutuba* trees on their land for hundreds of years and that these have always kept the land fertile. *Mutuba* trees are increasingly part of an informal, sustainable, integrated agroforestry system promoted in Bukomansimbi district by Stephen Kamya of BOTFA, re-implementing traditional knowledge, as they provide shade for other food crops and nutrients for the soil. Local people understand what governments and big corporations choose not to, through their everyday, lived experience of the benefits to local culture, agriculture and health that are derived from the *mutuba* tree. However, incentives continue to be offered for indigenous trees to be cut down in order to plant environmentally degrading eucalyptus crops, oil palm trees or sugar plantations - for short term financial gain but at enormous cost to local biodiversity. In 2019,

the negative impact of a eucalyptus monoculture plantation on other agriculture in its vicinity was witnessed, as eucalyptus drains the soil of moisture for a large area around and thus impoverishes noticeably the yield of other crops. It is difficult, however, to argue against these economic opportunities when local people would otherwise live in extreme poverty, so it is crucial to develop responsible alternatives that may provide a sustainable income. This matter requires urgent attention, as the ancient forests and ecosystems of Uganda are being depleted irrevocably for short-term gain – which was witnessed first-hand by team member Kirsten Scott in 2019 and confirmed in discussions with local community members.

Bark cloth or *lubugo* making begins with the careful harvesting of the bark by shaving off the trunk's outermost layer, before splitting the next layer down the length of the tree and gently peeling it off with a sharpened banana tree stalk (Figure 1). This activity is normally performed during the rainy season, when the trees have more sap, so the bark is suppler and the trunk is less likely to be harmed by the process (Nakazibwe 2005; supported by interviews with BOTFA members in 2019). In this way, the bark may be harvested annually without damaging the tree. The naked, seeping trunk is wiped down and then wrapped in banana leaves for a few days to protect the tree as it recovers, therefore banana trees are frequently grown close to *mutuba* trees for convenience (Figure 1).

Figure 1: *Bark cloth artisans Paul Bukenya Katemiira and Vincent Kajooga, stripping a mutuba tree*, 2019. Bukomansimbi, Uganda. K. Scott.

The stripped bark is boiled in water to soften it, then pounded over a long, smooth, wooden block with a series of ridged, wooden mallets (made from the hard wood of an increasingly rare indigenous tree, (known locally as *enzo* and in Latin as *teclea nobilis*), in a sheltered workshop for three to five hours, or even longer depending on the size of the bark. Through this process, the bark fibres 'felt', becomes finer, softer and more pliant, and the sheet grows in size significantly (Nakazibwe 2005; Figure 2; supported by field visit in 2019). It is then spread out in the sun for the natural, rich red-brown colour to develop that is favoured in the region and weighted down by rocks to dry. Finishing includes darning any small tears in the cloth with raffia and patching any larger irregularities before a final beating.

Figure 2: *The Bukomansimbi Organic Tree Farmers Association with their sheets of bark cloth*, Bukomansimbi, 2014. Uganda. K. Scott.

The processes described above demonstrate that bark cloth is made through a symbiotic relationship between man and *mutuba* tree, that it may sustainably be produced each year and that it plays an important role in a regenerative farming system that is crucial to the health of the local environment and community. In addition, community members shared that bark cloth is considered antibacterial, which became a focus of Dr Jonathan Butler's microbiology experiments and discoveries which were verified with laboratory research, detailed later in this article.

Design Practice and Philosophy – Kirsten Scott

A fundamental aspect of my design philosophy has become about finding ways that fashion might improve the health and wellbeing of peoples and planet. This has evolved through a somewhat serpentine, to-and-fro relationship between my reflective practice, field work in Uganda and conceptual frameworks drawn from architecture, engineering and health, such as biophilia, biodesign and biomechanics, and through fiddling around with pieces of bark cloth to see what they can do, by slashing, folding and stitching the cloth to sculpt new shapes and to reconceptualize my practice as a designer and passionate maker.

I began to consider how designers for the built environment address our affiliation with nature by using certain materials and forms, such as timber products and surfaces and curved shapes. Timber offers essential visual, haptic, aromatic and other intangible qualities that reconnect us to the natural world and has, therefore, been shown to improve human health and wellbeing when used in the built environment (Kellert and Calabrese 2015; Coutts and Hahn 2015; Bell and Ward Thompson 2014; Grinde and Patel 2009; Dodge *et al* 2012). If wellbeing may be defined as "feeling good and functioning well" (Department of Health and Social Care 2014: 6) - and embraces psychological as well as physical health – how might this be enhanced through a fashion design strategy (Center for Disease Control and Prevention 2019; Scott 2019)? If an individual's state of wellbeing may add years to life expectancy, improve emotional resilience, resistance to and recovery from illness, and may positively affect the wellbeing of others (DHSC 2014), how can this be amplified in the ways that we source and work with materials, techniques and design processes to improve the wellbeing of others, including the non-human? What beneficial systems might be conceived if these are our guiding principles? A working hypothesis is that clothing made from bark cloth may transmit tangible and intangible benefits to the health and wellbeing of its wearers, which will be tested when the research team expands to include experts in this field.

Bark cloth may sustainably be sourced in carefully managed quantities, directly from its makers in Uganda to provide them with a sustainable income stream. As described above, the processes associated with its production reflect a harmonious relationship between human and non-human species that has been tested and refined over many centuries. Bark cloth is naturally antibacterial and mosquito repellent; every part of the mutuba tree is used in local medicine in some way; it provides nutrients to the soil and is key to local agroforestry - therefore its beneficial properties to people, to livestock, to farming and to soil health are well established by centuries of local, empirical evidence that is now beginning to be tested, confirmed and measured in the controlled conditions of Western science. That knowledge obtained through Western science continues to be privileged in academia and industry over traditional ecological knowledge (TEK) requires more discussion than is within the scope of this article: we recognize, with humility, that academic research methodologies are in urgent need of decolonization, and of an openness to other ways of knowing (Tuhiwai Smith, 2021). We remember how many things that have become central to our wellbeing in Western societies - such as aspirin, quinine, morphine, for example – originated in the knowledge systems of indigenous peoples who received little credit and even less recompense for them (Popp 2018, Keane et al 2017).

While bark cloth has a beautiful, matt surface that may be compared to suede or even a woven linen, it is not without challenges when used in clothing, as mentioned previously: it can tear easily down the length or split; it absorbs lots of water; its surface wears down; each piece is unique, so it is difficult to establish continuity or uniformity; and its natural colour is strong and very specific.

Figure 3: Kirsten Scott. *Biophilic coat.* 2019. Bark cloth. K. Scott.

Thinking through making, I have evolved a particular design approach that accommodates and even celebrates the limitations of the cloth while acknowledging our affiliation with nature. To enable more versatile colour, I have used a historic ebonizing technique to dye the bark cloth black, or collaborated with Karen Spurgin and ao textiles for it to be dyed with indigo, or have sourced mud-dyed bark cloth directly from its makers. My silhouettes and pattern making are informed by biophilia and biomechanical theory: through exaggerating pressure points and curving shapes and seamlines, I have been able to respond to and even celebrate the specific limitations of the cloth in a way that relates to body movement

requirements and the rounded forms found in nature (Gupta 2011; Venkatraman and Scott 2018, Figure 3): designing for the cloth rather than adapting the cloth to my design. Slow, neocrafting techniques, including applique and surface manipulations, have strengthened as well as decorated the garments to promote emotional attachment, durability and amplify the bark-like texture (Figure 3). The rhythmic stitching is peaceful, meditative, and cathartic.

Natural dyes and surfaces - Karen Spurgin

Drawing on various strands of my practice, my investigation into bark cloth has centred on surfaces and finishes, exploring colour and stitch. As we use the Borrowed Cloth model (Scott, 2019), it is important that key research be handed back to the community. With this in mind I began to look at possible, sustainable, low-tech surfaces for bark cloth that were repeatable and, in time, scalable. Although the rich terracotta colour natural to bark cloth is popular in Uganda, it was felt that it carries connotations of handicraft to other audiences. As it was important to create a colour that relates well to the luxury fashion market, the choice of black was made.

To address the need for a solution that delivered low environmental impact, natural dyes were employed to achieve various shades of black. My research led to an examination of medieval tempera painting techniques and an investigation of textiles from China, including Liang Chou silk and the ‘shiny silk’ of the Miao people. A series of trials developed recipes for black that included the natural dyes logwood and indigo, the most successful of which was logwood, which is a plant-based dye extracted from the heartwood of the logwood tree (*Haematoxylum capechianum*) (Wild Colours, no date), obtained from renewable sources. The use of this dyestuff, as a saturate solution, allowed me to create a paint that could be applied to bark cloth without permeating the material. While the colour worked well, the bark cloth surface was dry and patchy. It did not have the depth of colour and quality of surface I envisioned.

This led me to the methods of medieval tempera painting - various trials established that I was able to reduce waste by sizing the bark cloth with a dilute solution of glair made with egg whites (Ventor, 2018). A layer of egg yolk added to the logwood solution mimicked tempera paint and allowed me to introduce suppleness and flexibility to the textile. The addition of egg yolk also contributed several other useful properties: after being allowed to harden over time the surface becomes exceptionally robust, scratch resistant (Ventor 2018) and waterproof (Willoc mac Muirdaig 2013). Both disciplines work in a similar way, creating

surfaces by building layer on layer using a variety of mediums, such as dyes and pigments, egg and yam juice and even pig's blood in the case of Miao textiles. Replicating the glair varnish (Willoc mac Muirdaig 2013) used in tempera and building layers as in Miao practice resulted in a black shiny 'leather like' surface. Indigo or a logwood coating achieved a deep blue-black or a true glossy black respectively. The use of simple materials kept the circular ethos at the centre of the process.

Following on from this research, I concluded that the natural dyes were an intriguing direction to take the research. Mindful of the already acknowledged anti-bacterial properties of bark cloth and recognizing such considerations additionally are part of the Miao textile tradition - where the fabric is prized for its fragrance and moth repellent qualities (Lesso 2019) - I looked at ancient medicine traditions where dye plants are often integrated into textiles as part of an holistic view of the wellbeing of an individual, for example, contributing healing, cooling, UV protection and medicinal properties.

Continuing research then focused on the 5000-year-old Indian Ayurvedic tradition. Ayurveda means the mother of all healing and is based on the principle of balance and prevention (Thakker 2020). Within Ayurveda is the idea that textiles can be used to impart health benefits through the skin. There is evidence of this across the world with examples, for instance, in Chinese medicine and acknowledgement of health-giving properties contained in dye plants embedded in Japanese Kanpo herbal medicine (Kakuro and Kakuro 2019). It is thought that this concept has its origins in India with Ayurvastra (*ayur* health and *vastra* clothing). Drawing upon this ancient wisdom, I have adapted some therapeutic, natural dyes to create finishes for the bark cloth. This finish improves the strength and water resistance of bark cloth alongside promoting human health and wellbeing (Jyothirmi and Panda 2016).

The skin is our largest organ. There is mounting evidence that our use of synthetic fibres, dyes and finishes are not benign (Thakker 2020). For example, synthetic compounds in the textile supply chain - including dyes - often manifest as endocrine disrupters and can be carcinogenic. Several studies suggest that the chemical load carried in fibres we wear may be absorbed by prolonged contact with the skin. This is an emerging topic feeding into current debates around the use of synthetic colour and has become a primary interest of mine.

> Despite the possible impact on human health, few studies have been conducted to assess the penetration and accumulation of contaminants in the skin after a prolonged contact with textile materials. (Iadaresta 2018: 24629).

Figure 4: Karen Spurgin, *Embroidery sample, using bark cloth dye*, 2020. Silk and bark cloth. K.Spurgin.

Additionally, my research addresses the goal of zero waste. Acknowledging that bark cloth is a valuable material, all off-cuts are saved. In line with the Ayurvastra tradition, one strand of my research has utilized the bark cloth off-cuts to create a natural dye. Soaking the bark cloth produces an extract which has been used to dye various fibres and fabrics. The results so far have shown that the dye - when used in conjunction with scoured and mordanted fibres and fabric - creates a pink/tan colour (Figure 4). Initial light tests have been quite successful, particularly with protein fibres such as silk and wool. The fabric and subsequent embroidery (Figure 4) will be tested at Manchester Metropolitan University by Dr Jonathan Butler, Senior Lecturer in Microbiology to discover whether health-giving benefits remain trapped in the fibres and may be transferred through the skin. Should these experiments be successful, I am intrigued about what potential this may have, for example, for sportswear, children's clothes, and medical uses. We are only just scratching the surface.

Analysis of bark cloth for its mechanical properties - Prabhuraj Venkatraman

Bark cloth in its natural form is coarse, relatively rigid, has uneven texture, and possesses low strength. In addition, it has an uneven surface thickness, with thick and thin places within its typical structure, which makes it challenging to handle and form shapes. These distinct characteristics are due to its natural origin of the Mutuba tree (*Ficus natalensis*), and the fibre strands possess diagonal patterns and, in some areas, a criss-cross arrangement of fibre strands. These bark cloth patterns and grain movements are also due to its traditional treatment, which includes steaming and soaking to soften its texture and pounding with wooden mallets, which could also include mild stretching. Various aesthetic and physical properties were investigated to determine the feasibility of bark cloth as a textile material. These include measurement of fabric thickness, area density, fabric drape, tensile strength, and tearing strength.

Bark cloth has a fabric weight of 143 g/m^2 and a thickness of 0.67 mm, indicating that the material possesses an average area density comparable to a typical low weight nonwoven fabric. A drape coefficient of 94.7% indicates that the material is stiff on its own, affecting its handle and its ability to form shapes. As a rule of thumb, a material should possess medium drape between 50-60% to aid in handling, processing, and forming shape; material with low drape coefficient (<20%) is pliable, whilst material with high drape coefficient (>90%) is

stiff, (Venkatraman et al., 2020). In addition, the bark cloth in its grain direction possesses high rigidity, indicating that the material is rigid in grain direction compared to cross direction.

The tearing strength is also a method of evaluating the ability of the material to withstand wear and tear, which is the force required to rip the material. Finally, the tensile strength in the lengthwise direction was 57N compared to 25N in the cross direction. These mechanical tests show that bark cloth must be treated to ensure it can be used as a sustainable product. In our previous study, we used interfacings to reinforce the fabric, offer stability, enhance strength, incorporate surface designs and patterns using CO_2 laser and sublimation print techniques and allow shaping into garments (Venkatraman et al., 2020). Further to these explorations, the current focus is to develop methods and processes to identify a natural biopolymer to offer mechanical stability to the bark cloth and replace conventional interfacings. Our future work will endeavour to improve the mechanical characteristics of bark cloth using environmentally-friendly sustainable methods and undertake a series of consumer wearer trials to identify user perception and in addition to determining the skincare benefits of wearing bark cloth. It is worth mentioning that textiles and clothes can induce contact dermatitis in cases where clothing is worn treated with azo dyes (classified as allergenic), especially with dark-dyed clothes or continuous contact between skin and cloth with increased perspiration or in the skin fold region (Svedman et al., 2019). Future studies will explore the potential benefits of wearing bark cloth to improve skincare or alleviate any dermatitis symptoms.

Biomedical and clinical applications - Jonathan Butler

Antimicrobial resistance is a major global issue (Blair *et al*. 2015) and it is estimated that by 2050, mortality rates associated with antimicrobial resistant infections will exceed 10 million people per annum, superseding cancer as the leading cause of global mortality (O'Neill 2016). Furthermore, it is estimated that between 7% and 10% of hospitalized patients will develop a healthcare associated infection (HCAI) (Danasekaran *et al*. 2014). One method of reducing HCAIs is the use of antimicrobial textiles and wound dressings (Negut *et al*. 2018), with many currently employing metals or synthetic compounds as the active antimicrobial agent. However, a more environmentally sustainable approach is the use of antimicrobial fabrics derived from natural sources. There are many reports of naturally occurring antimicrobial agents and one emerging area is the use of tree bark extracts.

Previous research has focused on the antimicrobial efficacy of tree bark extracts from *Diplotropis ferruginea* (Cerqueira *et al.* 2011), other tropical and subtropical tree barks (Perez *et al.* 2001) and *F. natalensis* (Butler *et al*., 2020). The latter study was the first report where an unmodified whole bark cloth made by traditional methods had been used as an antimicrobial fabric against methicillin-resistant *Staphylococcus aureus (*MRSA), a major cause of bacterial HCAIs and wound infections (Haque *et al*. 2018). In this study, a 99% reduction in bacterial viability after 4 hours was observed when bark cloth was exposed to MRSA and after 24 hours, this increased to a 99.99999% (seven-log) reduction in bacterial viability (Butler *et al*., 2020). It was suggested that the bark cloth caused morphological changes in the bacterial cellular ultrastructure after contact exposure to the fabric material. It was further observed that MRSA cells became irregular in shape, with invaginations, holes and perforations and there was also evidence of extracellular cytoplasmic leakage (Butler *et al.*, 2020), which caused the antimicrobial effect. The active antimicrobial compound(s) from bark cloth remains to be elucidated, but elemental analysis revealed the presence of chlorine, calcium and magnesium on the surface of bark cloth (Venkatraman *et al.* 2020), all of which possess antimicrobial activity (Xie and Yang 2016). Likewise, triterpenoids and quinones such as tectoquinone, have previously been identified from crude *F. natalensis* extracts by vacuum column chromatography (Awolola *et al.* 2017), and may contribute towards the observed antimicrobial activity exhibited by whole bark cloth products.

Bark cloth possesses the key characteristics of wound dressing technology, including good porosity (Venkatraman *et al.* 2020), antimicrobial activity, mechanical protection, environmentally sustainable and cost effective. Overall, natural bark cloth is ideally suited for use in wound care management and understanding the role of bark cloth in assisting the wound healing process would provide further insight into developing applied and clinical applications.

Conclusion

This cross-disciplinary, cross-institutional, cross-cultural project is seeking ways to integrate the benefits of an endangered forest product in luxury fashion garments, while navigating the specific characteristics, limitations and opportunities presented by bark cloth in supporting the health and wellbeing of peoples and planet. In the process of our research, new ideas and potentialities continue to emerge that orientate us towards a deeper understanding of how we might collaborate with nature to source materials that are wholly benign and which may offer

solutions to global challenges, such as the stress epidemic, from MRSA and more. There is substantial evidence that time spent in forests – even touching bark – has a positive effect on human health and wellbeing: how much more so, if we were to wrap ourselves in that bark? In addition, bark cloth's ability to combat MRSA and, therefore, its potential as an effective, environmentally sustainable wound dressing are important to examine further in order to understand the opportunities that this might present for the Bukomansimbi Organic Tree Farmers Association and other *mutuba* tree growers in Uganda. The research strongly asserts that there are important lessons to be learned from indigenous knowledge systems that form the intangible cultural heritage of humanity, such as bark cloth making and the role that the *mutuba* tree plays in Ugandan culture and agroforestry, that have fresh relevance to how we might better live on the Earth.

As indicated above, there are particular challenges attached to using bark cloth in contemporary clothing: some of which we must continue to resolve. However, creative practice provides a space for reflection, for sense-making, for resolving and for futuring, while scientific and textile laboratory testing provide spaces for identifying, for measuring, for confirmation and for testing application: together we are stronger. Consultation with team members in Uganda enables us to share or gain new knowledge, check the feasibility of our ideas, to understand how they may need to be adapted or developed, and to learn from the views of local actors and to gain direction from them. Next steps include testing to measure and confirm the impact of wearing bark cloth (and of wearing fabric dyed with bark cloth scraps) - our secondary research and field interviews suggest that this is likely to confer benefits to the health and wellbeing of wearers through the skin and perhaps in other ways. Through our collaborative research, we propose a benign and truly holistic approach to creating fashion garments that promote the wellbeing of their wearers, of their makers and of the planet. Perhaps crucial to this project has been the organic nature of a research team that is able to expand and contract in response to needs and developments that arise; a team that was initiated relatively informally, drawn together not by one institution but rather by a shared interest in and an openness to the potential of a Ugandan cultural cloth and the tree from which it is created. Through diverse disciplinary perspectives, we have been able to think much more expansively about bark cloth's potential than if we had remained within the confines of our own discipline. We are excited about where this project might lead us and the Bukomansimbi Organic Tree Farmers Association.

References

Armstrong, Cosette M., Niinimäki, Kirsi. and Lang, Chunmin., (2016) Towards Design Recipes to Curb the Clothing Carbohydrate Binge, *The Design Journal*, 19:1, 159-181, DOI: 10.1080/14606925.2016.1109207

Awolola, Gbonjubola V., Chenia, Hafizah, Baijnath, Himansu and Koorbanally, Neil A. (2017) Anti-adhesionpotential of non-polar compounds and extracts from *H. natalensis*. *Rev Bras Farmacogn* **27(5)**, 599-602.

Bell, Simon & Ward Thompson, Catherine, (2014). 'Human engagement with forest environments: implications for physical and mental health and wellbeing'. In T Fenning (ed.), *Challenges and Opportunities for the World's Forests in the 21st Century. Forestry Sciences*, vol. 81, Springer Netherlands, Dordrecht, pp. 71-92. DOI: 10.1007/978-94-007-7076-8_5

Blair, Jessica M., Webber, Mark A., Baylay, Alison J., Ogbolu, David O. and Piddock, Laura J. (2015) Molecular mechanisms of antibiotic resistance. *Nat Rev Microbiol* 13(1), 42-51.

Butler, Jonathan A., Slate Anthony J, Todd David B., Airton, Douglas, Hardman, Michelle, Hickey, Niall A., Scott, Kirsten, and Venkatraman, Prabhuraj D. (2020) 'A traditional Ugandan Ficus natalensis bark cloth exhibits antimicrobial activity against Methicillin-Resistant Staphylococcus aureus', *Journal of Applied Microbiology*, The Society for Applied Microbiology, https://doi.org/10.1111/jam.14945

Center for Disease Control and Prevention. (2019). *Well Being Concepts*. https://www.cdc.gov/hrqol/wellbeing.htm#three

Cerqueira, Gilberto S., Rocha, Nayrton, Almeida, Jrgs, de Freitas, Apf, Lima, Eo, Filho, Jmb, de Freitas, Rm and Diniz, Melo M., (2011) Antimicrobial activity of the extract of stem bark of *Diplotropis ferruginea* benth. *J Young Pharm* 3(4), 284–286

Chappe, Raphaele. and Lawson, Cynthia, (2020). 'Artisans and Designers: Seeking Fairness within Capitalism and the Gig Economy' in *Dearq* (26): 80-87. https://doi.org/10.18389/dearq26.2020.09

Coutts, Christopher and Hahn, Micah, (2015). 'Green Infrastructure, Ecosystem Services, and Human Health' in *International Journal of Environmental Research and Public Health*, (2015) vol 12, Basel: MDPI AG, available from: http://www.mdpi.com/1660-4601/12/8/9768/htm, [accessed on 05/04/18]

Danasekaran, Raja., Mani, Geetha and Annadurai, Kalavaini (2014) Prevention of healthcare-associated infections: protecting patients, saving lives. *Int J of Community Med Public Health* **1(1)**, 67-68

Department of Health and Social Care. (2014). *Wellbeing and Why it Matters to Health.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/277566/Narrative__January_2014_.pdf

Dodge, Rachel, Daly, Annette P., Huyton, Jan, & Sanders, Lalage D., (2012). 'The challenge of defining wellbeing'. *International Journal of Wellbeing*, vol 2(3), pp 222-235. (doi:10.5502/ijw.v2i3.4)

Fletcher, Kate. and Tham, Mathilda, (2019*). Earth Logic Fashion Action Research Plan*. London: The J J Charitable Trust. Found at: https://katefletcher.com/wp-content/uploads/2019/10/Earth-Logic-plan-FINAL.pdf

Global Wellness Institute. (2018). *Global Wellness Economy Monitor,* https://globalwellnessinstitute.org/industry-research/2018-global-wellness-economy-monitor/

Grinde, Bjørn and Patil, Greta G., (2009). 'Biophilia: Does Visual Contact with Nature Impact on Health and Well-Being?' in *International Journal of Environmental Research and Public Health*, vol 6(9), pp 2332-2343. (doi:10.3390/ijerph6092332).

Gupta, Deepti, (2011). 'Design and engineering of functional clothing', in *Indian Journal of Fibre & Textile Research*, 36:327, found at http://nopr.niscair.res.in/handle/123456789/13226, [accessed on 12/09/18]

Hammer, Timo R., Fischer, Kirsten, Mueller, Marina and Hoefer, D., (2021), Effects of cigarette smoke residues from textiles on fibroblasts, neurocytes and zebrafish embryos and nicotine permeation through human skin, https://www.sciencedirect.com/science/article/abs/pii/S1438463911000496, accessed 20/04/2021.

Hansen, Margaret M., Jones, Reo, Tocchini, Kirsten (2017). "Shinrin-Yoku (Forest Bathing) and Nature Therapy: A State-of-the-Art Review." *International Journal of Environmental Research and Public Health*, 14, 8: 851. Found at https://doi.org/10.3390/ijerph14080851

Haque, Mainul, Sartelli, Massimo, McKimm, Judy and Abu Bakar, Muhamad, (2018) Health care-associated infections - an overview. *Infect Drug Resist* **11**, 2321–2333.

Health and Safety Executive (2020), *Work-related stress, anxiety or depression statistics in*

Great Britain, 2020. Available from https://www.hse.gov.uk/statistics/causdis/stress.pdf

Iadaresta, Francesco, Manniello, Michele D., Östman, Conny, Crescenza, Carlo, Holmback, Jan and Russo, Paola, (2018) 'Chemicals from textiles to skin: an in vitro permeation study of benzothiazole'. *Environmental Science and Pollution Research* 25**,** 24629–24638 (2018). https://doi.org/10.1007/s11356-018-2448-6

Ingold, Tim (2013). *Making: Anthropology, Archeology, Art and Architecture*, London: Routledge

Jyothirmi, Singothu and Panda, Sasmita, (2016). "Ayurvastra Herbal Clothing (A new technology to heal naturally). *International Journal of Advanced Research and Innovative Ideas in Education*, 2:4, pp 1166-1171, https://www.researchgate.net/publication/307580444_AYURVASTRA_-_HERBAL_CLOTHING_A_new_technology_to_heal_naturally. ISSN(O)-2395-4396

Kakuro, Sugimoto and Kakuro, Tetsuo, (2019) *Japanese Natural Dyes and Natural Remedies: Talk and Demonstration by Sugimoto Kakuro and Tetsuo*. https://www.japanhouselondon.uk/whats-on/2019/japanese-natural-dyes-and-natural-remedies-talk-and-demonstration-by-sugimoto-kakuro-and-tetsuo/, accessed 04/05/2019.

Keane, Moyra, Khupe, Constance and Seehawer, Maren K., (2017) 'Decolonising methodology: who benefits from indigenous knowledge research?' in *Educational Research for Social Change*, *6*(1), 12-24. https://dx.doi.org/10.17159/2221-4070/2017/v6i1a2

Kellert, Stephen R., Heerwagen, Judith H. and Mador, Martin L. (2008). *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*, London: Wiley

Kellert, Stephen R. and Calabrese, Elizabeth F., (2015). The Practice of Biophilic Design, available from www.biophilic-design.com [accessed on 04/04/18]

Lesso, Rosie, (2020) *Indigo in China, Ancient Roots*. https://blog.fabrics-store.com/2020/10/13/indigo-in-china-ancient-roots/, accessed 13/11/2020.

Morikawa, Takeshi, Miyazaki, Yoshifumi and Kobayashi, Shigeo, (1998) 'Time-series variations of blood pressure due to contact with wood' in *Journal of Wood Science* (1998), 44, 495-497

Nakazibwe, Venny, (2005). Bark cloth of the Baganda People of Southern Uganda: A Record of Continuity and Change from the late 20th Century to the early 21st Century, Doctoral Thesis, Middlesex University, available from: http://ethos.bl.uk/SearchResults.do

Picardie, Justine, (2005), *The Darkness* https://www.theguardian.com/lifeandstyle/2005/aug/28/fashion.shopping1

O'Neill, Jim, (2016) *Tackling drug-resistant infections globally: final report and recommendations.* London: Review on Antimicrobial Resistance.

Pérez, Salud G., Zavala, Miguel A., Arias, Lucina G., Pérez, Cuauhtemoc G. and Pérez, Rosa M. (2001) Antimicrobial study of bark from five tree species. Phytother Res 15(4), 356-359.

Popp, Jesse, (2018), 'How Indigenous knowledge advances modern science and technology' in *The Conversation*, found at http://fnmieao.com/resources/PDF's/How_Indigenous_knowledge_advances_modern_science_and_technology.pdf

Putra, Ricky R.F.A., Veridianti, Dominika D, Nathalia, Evelyn, Brilliant, Danny, Rosellinny, Graciella, Suraz, Cristina and Sumarpo, Anton, (2018). "Immunostimulant Effect from Phytoncide of Forest Bathing to Prevent the Development of Cancer" in *Advanced Science Letters*, Volume 24, Number 9, September 2018, pp. 6653-6659(7), found at https://doi.org/10.1166/asl.2018.12804

Rwawiire, Samson and Tomkova, Blanka, (2013). "Thermo-physiological and comfort properties of Ugandan bark cloth from Ficus natalensis", in *The Journal of the Textile Institute*, 105:6, 2014, pp 648-653

Scott, Kirsten, (2019) "Future luxury: fashioning wellbeing through holistic design" in Cantista, Isabel. and Sadaba, Teresa. eds. (2019) *Understanding Luxury Fashion: From Emotions to Brand Building*. London: Palgrave Macmillan

Svedman, Cecilia, Engfeldt, Malin & Malinauskiene, Laura, (2019) 'Textile Contact Dermatitis: How Fabrics Can Induce Dermatitis. Curr Treat Options Allergy' 6, 103–111 (2019). https://doi.org/10.1007/s40521-019-0197-5

Thakker, Alka M. & Danmei, Sun, (2020) 'Sustainable plant-based bioactive materials for functional printed textiles', *The Journal of The Textile Institute,* doi: 10.1080/00405000.2020.1810474

Trowell, Margaret and Waschmann, Klaus, (1953) *Tribal Crafts of Uganda*, UK: Oxford University Press

Tuhiwai Smith, Linda, (2021) *Decolonizing Methodologies: Research and Indigenous Peoples*, 3rd edition, London: Zed Books

UNESCO, (2005). '*Bark Cloth Making in Uganda'* found at: http://www.unesco.org/archives/multimedia/?pg=33&s=films_details&id=641, [accessed on 12/09/18]

Venkatraman, Prabhuraj, Scott, Kirsten and Liauw, Chris, (2019) "Environmentally friendly and sustainable bark cloth for garment applications: evaluation of fabric properties and apparel development" in *Journal of Sustainable Materials and Technologies,* 23, London: Elsevier. https://doi.org/10.1016/j.susmat.2019.e00136

Venkatraman, Prabhuraj and Scott, Kirsten, (2018) 'Investigation of bark cloth for its surface texture and durability for apparel applications' paper delivered at the *Textile Institute World Conference*, University of Leeds, 23/06/18-26/06/18. Found at http://www.tiworldconference.org, [accessed on 14/09/18]

Ventor, Juliet (2014) *About egg yolk and other traditional paint binders* http://www.juliet-icons.co.uk/egg-tempera-and-binders.html, accessed 05/06/2018.

Wild Colours (no date) *Logwood (Haematoxylum campechianum)*, http://www.wildcolours.co.uk/html/logwood.html, accessed 05/06/2018.

Willoc mac Muirdaig, (2013) 'Mixing your own Glair and Watercolor', *Known Worlds Heralds and Scribes Symposium 2013*., Found at: https://heraldry.sca.org/kwhss/2013/Willoc_mac_Muiredaig/KWSH2013-Pigments.pdf

World Health Organization. (2019) *Promotion of mental well-being.* http://www.searo.who.int/entity/mental_health/promotion-of-mental-well-being/en/#. Accessed 18th February, 2019

Figure 1: Barkcloth artisans Paul Bukenya Katamiira and Vincent Kajooga, stripping a mutuba tree, 2019. Bukomansimbi, Uganda. © Kirsten Scott.

Figure 2: The Bukomansimbi Organic Tree Farmers Association with their sheets of barkcloth, 2014. Bukomansimbi, Uganda. © Kirsten Scott.

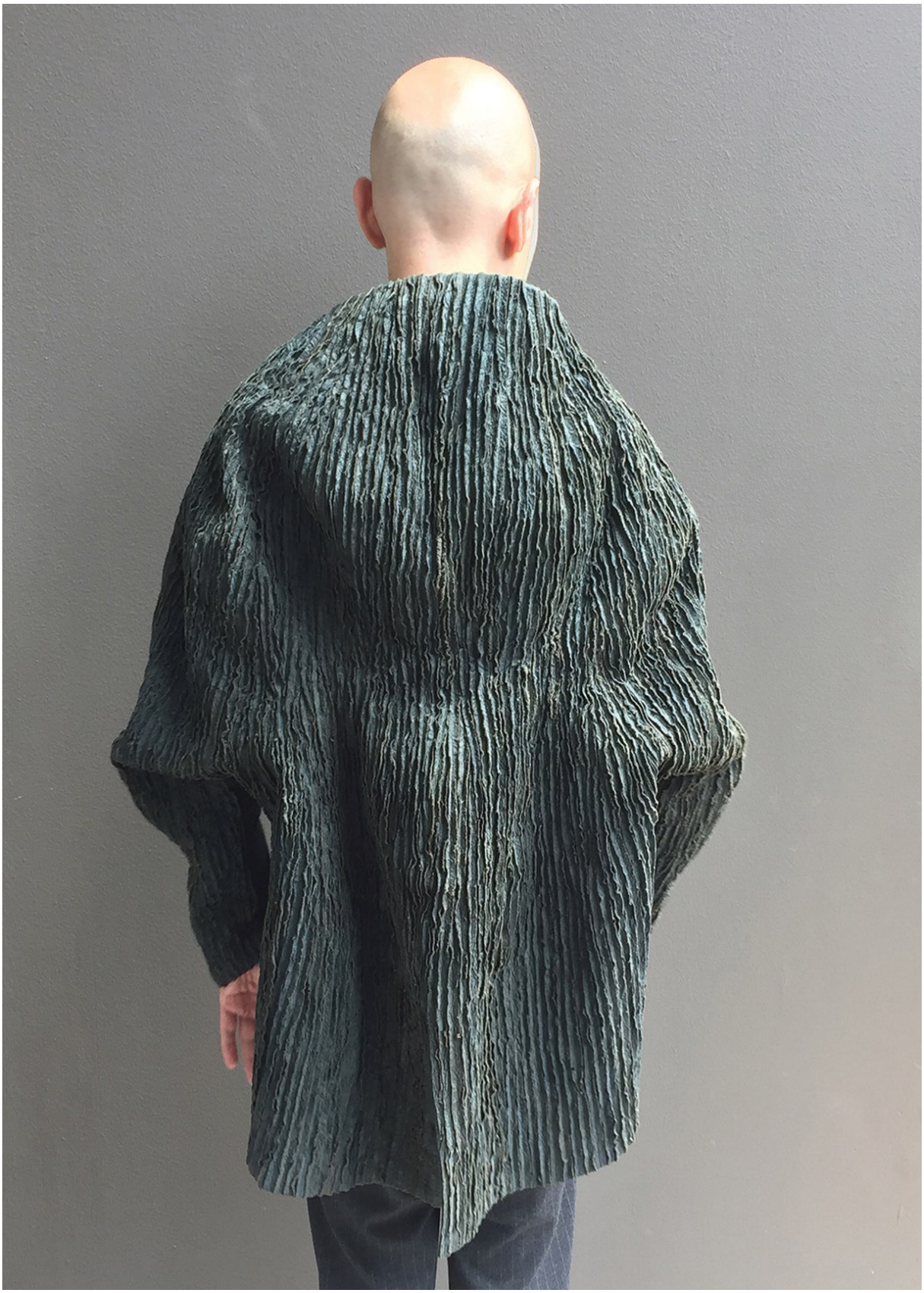

Figure 3: Biophilic coat, 2019. Barkcloth. © Kirsten Scott.

Figure 4: Embroidery sample, using barkcloth dye, 2020. Silk and barkcloth.