String bag patterns and colour dyes of the upper Sepik basin and Border Mountains

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PM E7490, Abau, Bifrou, Craig, 1968

Photographs by Andrew Fyfe unless stated otherwise.

Introduction

Last year Mantel tests involving string bags from three language groups from the Border Mountains and upper Sepik basin, the Abau, Namie and Yuri, and three from the adjacent highlands of central New Guinea, Tifal, Telefol and Mianmin, were undertaken to determine the degree to which distributions of techniques used in string bag construction correlated with either language affinity or geographical distance (Fyfe & Bolton forthcoming a). Both independents showed significant associations with string bag construction repertoires but after statistical control only a significant association between string bag construction repertoires and propinquity remained. On the other hand, there was no significant association between string bag construction and language affinity after geographical distance was under statistical control. This result indicates that episodes of exchange and transmission between neighbouring groups, coupled with some incidence of drift, were responsible for these distributions.

The distribution of the string bag pattern techniques discussed in the follow text has recently been submitted to a similar analysis (Fyfe & Bolton forthcoming b). This second analysis provides a comparable result, although the correlations are not as great. It is argued that as decorative pattern programs comprise smaller sets of techniques, are relatively interchangeable between bags made with different construction techniques, and are highly visible this may have led to greater transmission rates between peers from different social groups than would have occurred for construction technology (e.g. Pryor & Carr 1995). This has resulted in more pervasive distributions than those existing for construction repertoires leading to many instances where bags considerably distant from each other, both in terms of geography and the languages spoken in the villages where they were collected, having similar pattern programs.

Pigments and string bags

The deliberate colouring of string is widespread in many parts of mainland New Guinea and this is particularly the case in the lowlands of the upper Sepik basin and in the Border Mountains. Dyed string is used for a range of body ornaments, such as bands and straps worn on the arms, chest and legs, and a range of single colour or multicolour patterns were commonly applied to string bags. In the 1970s Kelm and Kelm (1980: 179-80) concluded that in Ak and Awun speaking communities of the Yellow River area only men's bags were decorated. While this contrast would be understandable, considering the large 'domestic' bags women carry would not only have required more effort to embellish but the constant wear and soiling of such bags would have more quickly undermined the patterns, two of the five large bags they collected and recorded as being used by women were decorated with dyed string. Along with these almost all the large string bags from the lowland and Border Mountain groups are decorated with dyed string. The major difference between these and the typically smaller men's bags is that the patterns are usually less complex and less apparent.

Unfortunately, information concerning the sources of pigments used for string dyeing is limited and very few of the string bags in the entire sample from this region are provided with information concerning the origin of their colours. By far, most existing information was compiled by Mouli MacKenzie during fieldwork in both regions in 1982. By the time of MacKenzie's arrival, a range of introduced sources had become available, however, in the communities she visited, the vast majority of pigments were sourced from local plants. Indeed, many of the earlier collections, most of which were acquired in the 1960s, appear to have a similar incidence of traditional and introduced pigments.

Traditional plant sources for dyes

Plant sources appear to have supplied almost all of the traditional pigments used to dye string in these regions during the time the collections were made. The plant sources that have been identified in the record include:

- The rhizomatous perennial *Curcuma* sp*.,* commonly known as turmeric, and possibly other closely related members of the family *Zingiberaceae*. The juice usually produces a strong yellow and can be mixed with ash or lime to provide an orange/orange-red (MacKenzie 1982 a & b; Juillerat undated).[1]
- Fruit of the annatto bush *Bixa orellana*. These provide bixin, a red carotenoid from the coating around the seeds. It is used for red, red-brown, or a rusty orange when unripe (Kelm & Kelm 1980: 180; MacKenzie 1982 a & b). The plant is not native to New Guinea, it is endemic to Central and South America and was introduced to New Guinea within the last 450 years.
- Seed capsules of *Cypholophus latifolius*, a member of the nettle family (*Urticaceae*). These typically produce a dark-blue/blue-black or blue-grey pigment but the record indicates that they also resulted in a turquoise or blue-purple (Juillerat undated; MacKenzie 1982 a).
- Seed capsules of *Melastoma polyanthum*. The fruit is grey-black when ripe, and contains purple pulp full of small black seeds. These are reported as providing a purple dye for Abau communities of the Idam Valley (Craig 1973: supplementary notes). The berries can also provide a black dye as has been observed amongst the Yali of West Papua (Milliken undated).
- A long pinky root of a shrub (MacKenzie 1982 a). This is reported as providing a pink or rusty brown. It also was used with lime or ash to provide a deep red.
- Leaves from *Ficus* sp. These can provide a dark brown/maroon or a 'dusky-pink'(MacKenzie 1982 a).
- Leaves from sweet potato (*Ipomoea batatas*). These are recorded as providing a green dye (MacKenzie 1982 a).
- Red leaves from an unidentified shrub or small tree. MacKenzie (1982 a) reports that the small leaves 'give a brighter red than larger new leaves'; also that they can 'stains hands like henna'.
- A red fungus. This also provides a red (MacKenzie 1982 a).
- A type of tree fern provided a black (MacKenzie 1982 a).

The most commonly reported dyes sources were *Curcuma* sp., *Bixa orellana* and *Cypholophus latifolius*. All were observed being used throughout the Border Mountains and upper Sepik basin*. Curcuma* sp. was a particularly important plant in terms of

[1] Sources cited in this list account for the description of pigments in the following text and therefore will not be further cited except where page number exist in the source and differs from those cited in the list.

cultural significance. Juillerat and MacKenzie respectively use the terms '*Curcuma* sp.' or 'turmeric' when referring to this important source of yellow for the Waina and Amanab speaking people of the northern and eastern Border Mountains. A sketch of the plant made by MacKenzie clearly illustrates a stem and base root of a *Curcuma* sp. Juillerat and MacKenzie report that the Waina and Amanab speaking communities, who called the pigment *loch*, use it to paint their bodies, drums, trumpets, sago petioles, and other fibre-based paraphernalia such as masks, during ritual. It is mixed with saliva and lime or kaolin for such purposes (Gell 1975: 190). Believed to have magical properties, the roots are also reported as being kept in small amulet string bags as charms to entice the intervention of spirits (Juillerat undated). Information of its use in the lowlands is less clear but one of the two major forms of a root − the other is discussed below − used in the region is commonly termed 'ginger' or 'yellow *kawar*' (Tok Pisin for ginger) by MacKenzie. It is most likely that this too was a *Curcuma* sp.; vernacular for the root was *wugno* − Abau Central (Abau-C) dialect, *bogno* − Abau Down-River (Abau-DR) dialect, and *dawubari* or *aitwar* (Namie). In the lowlands ginger is used to achieve a bright yellow (Figure 1). It is commonly mixed with lime or ash to achieve an orange or red.

Figure 1. String bag documented (Mackenzie 1982b) as having colours derived from *wau,* (*Bixa orellana*): orange, and *wugno* (ginger root): yellow (Sydney E88870, Abau, Deiru, MacKenzie, 1982).[2]

Bixa orellana is also used to paint both paraphernalia and participants during rituals (Juillerat undated). Its importance has meant that it is sometimes planted in the settlement by the women (Kelm & Kelm 1980: 180). Although in most cases MacKenzie describes the application of *Bixa* resulting in a 'rusty' red, freshly applied *Bixa* is often a rich

[2] The attribution sequence is: museum and accession number, language group, settlement collected, collector. Museum identities: Amsterdan: Tropen Museum; Berlin: Ethnologisches Museum; Leiden: Rijksmuseum voor Volkenkunde; Paris: Musée du quai Branly; PM: Papua New Guinea National Museum, Port Moresby; Sydney: Australian Museum; Vienna: Museum für Völkerkunde.

scarlet-red (Figure 2). Examples in the collections where *Bixa* is recorded as having been used typically exhibit a faded light orange (MacKenzie 1982b), which is to be expected as the pigment deteriorates rapidly when exposed to both sunlight and air. On some bags the *Bixa* colour is still a quite strong rusty red, presumably because the bag was collected soon after completion (Figure 3). It appears as though *Bixa* is usually applied directly as there is no mention of any modification.

Figure 2. Waina woman looping string with pigments likely to have been extracted from the seed capsules/berries of *Cypholophus latifolius* (blue-black), and *Bixa orellana* (red). Waina-Sawonda. Photo Mouli MacKenzie.

Figure 3. String bag documented as having colours derived from *wau,* (*Bixa orellana*): orange, and *Sobwen:* blue-purple (Sydney E88861, Abau, Bifrou, MacKenzie, 1982).[3]

A bluish-black/grey is probably the most common colour found on string bags in the sample (Figure 4). Where documentation exists the colour is predominantly attributed to the application of juice from the berries of *Cypholophus latifolius*. According to MacKenzie *urap* is a common term for this plant amongst Amanab and Waina speakers, while *kofiornai* and *nanefior* (Abau), and *kurabu* (Namie) were the most common terms used by people living near the Sepik River.

S*obwen* is another Abau term (Namie: *mitwan*) for a blue/purple berry described by MacKenzie as resulting in either a dark or pale purple/blue-purple. MacKenzie's notes are unclear as to the identity of the plant source but they imply it was not *Cypholophus latifolius* because vernacular for *Cypholophus latifolius* is given for another colour in the same context.

[3] The attribution sequence is: museum and accession number, language group, settlement collected, collector, date collected. Museum identities: Amsterdan: Tropen Museum; Berlin: Ethnologisches Museum; Leiden: Rijksmuseum voor Volkenkunde; Paris: Musée du quai Branly, PM: Papua New Guinea National Museum, Port Moresby; Sydney: Australian Museum; Vienna: Museum für Völkerkunde

Figure 4. String bag with string coloured with the berries of *Cypholophus latifolius* (Paris 71.1974.35.174, Amanab, Petaineri, Juillerat, early 1970s), Photo Musée du quai Branly**.**

However, as berry colour can vary considerably, particularly according to ripeness, this may have in some cases resulted in the assumption of an alternative plant source. Variation due to dialectical differences within language groups may have created additional misunderstandings. This may in part explain differences between the berry inventory of the Abau-DR dialect settlement of Beimap, where the presence of *sobwen* is not recorded and *kofiornai* is reported as producing a 'bright purple', while in Dieru village within the Abau-C dialect region, where '*sobwen* = blue-purple' and *nanefior,* blue/blue-black/blue-grey/blue-green − the Namie are recorded as having a similar distinguishing tendency: '*mitwan*: purple berries; *kurabu*: blue'. However, later at Wagu, another settlement of the Abau-DR dialect, MacKenzie provides no mention of *kofiornai* but writes '*sobwen* = *narafine'* − note the similarity of *narafine* and *nanefior*. MacKenzie goes on to conclude that at Wagu two colour sources- '*narafine* = purple berries' and *bogno* were used almost exclusively, indicating that in some villages there was also a strong colour preference. Somewhat in agreement with MacKenzie's observations, the three bags in the Wagu sample have a predominance of a plum-purple with one having some turquoise and another a small amount of black (Figure 5). However, it is unlikely that this plum-purple was produced with *sobwen* berries because this conflicts with MacKenzie's observation that *sobwen* produced a blue-purple and the incidence of a blue-purple on bags MacKenzie records as being coloured with *sobwen* (Figure 3). At this point therefore there are no more candidates for the identity of *sobwen* other than *Cypholophus latifolius,* particularly if one compares colours on bags in figures 3 and 4. As far as the plum-purple is concerned this is more likely to have been produced by the berries of a *Melastoma* sp., or even the fruit of *Pittosporum pullifolium,* both of which are used elsewhere in New Guinea for dying string purple.

Figure 5. String bag with plum-purple colouration (PM E11618, Abau, Wagu, Gerrits, 1969).

Apart from the roots source identified as *Curcuma* sp. (turmeric or ginger), there is another MacKenzie describes as being used to dye string, although again there may be some instances where this root was confused with a ginger variety. The root, commonly termed *kimeriu* in the Abau-DR dialect settlements of Bifrou and Beimap, where it appears to have been intensively used, is prepared in a similar fashion to that reported for the *Zingiberaceae*, in that it is either directly applied to string after the outer skin is removed or modified with white ash or lime to produce a richer red colour. However, the outer skin of this root can also be used and when rubbed directly onto the string this also creates a red colour, seemingly without lime or ash. Fortunately, the root and plant are sketched in MacKenzie's fieldnotes, which also record the plant as growing on the open banks of small streams. The illustration shows the root as being long and thick with small side roots and the leaves large with strong veins. There is also a sketch of what appears to be a composite fruit. From these descriptions the candidate is probably *Morinda citrifolia,* commonly known as the cheese-fruit tree or Indian mulberry. The root's skin and interior, are used by communities across southern and south eastern Asia, the Pacific, Australia and Central America to provide a wide range of colours including yellow, red, lilac, scarlet, pink, dull-purple, red-brown or black (Morton 1992: 245). In terms of use by communities other than those of the Abau, it is likely that the *Morinda citrifolia* root is responsible for a deep red-brown, which the Namie term *marawei*.

The use of 'red leaves' is mentioned only a few times in MacKenzie's notes and in all cases these are observations made in lowland communities. An Abau vernacular for these leaves is *mur[l]bar* and for the Namie speaking Tipas community *tsugnawi*. MacKenzie's descriptions suggest that the source was possibly a Coleus, either *Solenostemon scutellarioides* or *Plectranthus scutellarioides* (Dwarf Coleus), or *Iresine herbstii* – commonly known as Bloodleaf (Powell 1976: 151). A good description of the use of *Plectranthus scutellarioides* as a string dye in New Guinea is given by Sillitoe (1983: 130-31) who records it as the most important dye source for the Wola of the Southern Highlands of Papua New Guinea. Wola women prepare the leaves by heating them on the fire. This releases the sap which can then be squeezed out and applied directly to the string. The resultant colour varies from maroon to purple depending on the length of time the leaves were left on the fire. Conceivably therefore these are another candidate responsible for the plum-purple colour mentioned above.

The other two leaf-derived pigments reported for the lowlands, sweet potato and *Ficus* sp., are only mentioned a couple of times and appear not to have been commonly used. Sweet potato leaves were prepared simply by pounding after which the juice was applied directly to the string, as was observed in Bifrou by MacKenzie. *Ficus* leaves were recorded in use in Dieru and two Namie settlements, Yegarapi and Tipas. The preparation of *ficus* leaves is not described by MacKenzie although at Yegarapi she states that fresh leaves can produce a maroon while old leaves are responsible for the 'dusky-pink'. At Tipas, *ficus* leaves are described as producing a ginger colour. Presumably, like sweet potato leaves, these were pounded. In regards to the tree fern, recorded as being used for black in Beimap, it is unclear what part of the plant was used although fern roots have provided a black dye to craftspeople in other parts of the world (e.g. May 1978: 496).

MacKenzie observed the use of a fungus to produce red in Green River, where the Abau term for it was *taungan,* and at Yegarapi where it was termed *akwaioon.* The processing of the red fungus is also not well described but at Yegarapi it was mixed with water for application and therefore was presumably suited for steeping.

Other possible dye sources can be found among those tabulated in Hill's (2001) review of Papua New Guinea organic colourants. Beyond these, Table 1 provides more with references for literature that lists and describes them.

Non-plant derived and introduced colourants

Carbon in the form of charcoal could have been used for blacks and greys. For best results these would be mixed with fat. In addition to this, soaking the fibre or string in organic mud or peat can also result in a grey or black (Muller 2004: 45).[4] MacKenzie (1982) does report one example of an Abau woman burying string to achieve such an effect.

[4] This is also a common technique used by the Maori of New Zealand, although use is made of tannin from tree bark as a pre-mordant for a 'true' black (Pownall 1976: 96)

Table 1. Other plants of New Guinea known to produce dye

Latin name	Common name	Part used	Colour obtained	Colour with ash or lime	Reference
Burckella sp.		fruits			1
Leea indica	Bandicoot berry	berries			1
Areca sp.	Betel nut palm	seeds	yellow-brown		1 & 5
Pittosporum pullifolium		fruits	purple		3 & 6
Gardenia gjellerupii		berries	red-orange-yellow		3
Gardenia lamingtonii		fruits	orange		3
Iresine herbstii	Bloodleaf	crushed leaves and stems	red(?)		1
Melastoma malabathricum	Straits rhododendrum	fruits roots petals	black pink		1 & 4
Celosia argentea	Cockscomb	crushed leaves & stems (?)	yellow		2
Bidens sp.	Cobbler's pegs	petals	yellow		1& 5
Tagetes sp.	Marigold	petals	yellow & red		1 & 5
Adenostema hirsutum			black		2
Panicum sarmentosum			blue green		2
Phaius tankervilleae	Ground orchid	leaves	green		3

* ? indicates speculation

1. Powell 1976: 151
2. Muller 2004: 45
3. Milliken undated
4. Vardhana 2006: 538
5. Schetky 1978
6. Von Reis and Lipp 1982: 95

From the 1960s, introduced dyes and pigment sources would have become increasingly available from trade stores and via people visiting the patrol posts. Hanns Peter's records indicate that the Yuri predominantly used introduced dyes during his fieldwork with the Yuri in the late 1960s and early 1970s (Wellige 1996). Many of the bags Peter collected have deep primary blues and reds and these may have been powder dyes (Figure 14a). It is also possible that Reckitts blue and red and blue fountain pen inks were responsible.

MacKenzie reports the use of a number of introduced non-dye pigment sources in the early 1980s. These non-dye sources include the carbon from batteries, carbon paper and

Gentian Violet. The contents of the non-alkaline dry-cell batteries typical for the time would include a manganese dioxide/carbon powder stick with an electrolyte of zinc chloride and ammonium chloride. These would produce a black with a red-tone due to presence of the manganese. MacKenzie also reports that carbon paper provided a purple for the people at Green River and that carbon paper – presumably a blue variety – was also mixed with 'ginger' to achieve a green colour.

The use of Gentian Violet (a substance used to treat fungal infections) was reported by MacKenzie at a number of Abau villages. It typically results in lilac and light purple shades. A bag with patterns using this substance was collected by MacKenzie (Figure 6).

Figure 6. String bag decorated with Gentian Violet (purple). Red colour is possibly achieved with the use of *Morinda citrifolia* (Sydney E88862, Abau, Bifrou, MacKenzie, 1982).

Dyeing techniques: application of colour to the fibre/string

As steeping is suited to bast fibre it is practical to dye string before looping, particularly the processed fibre prior to spinning (e.g. Dean 1999: 50). Dyeing the fibre this way provides greater flexibility for the spinning process. It also enables larger quantities of fibre to be dyed. Introduced chemical dyes would have been particularly useful for this because large quantities are easily made and the result is more controlled. These dyes also would have encouraged larger areas of colour to be created. For the purpose of steeping, gourds would have been useful vessels, although during much of the period when the collections were acquired metal containers also would have been available to some people.

The planning required in terms of pre-dyed fibre is also relatively simple. Each *figure-eight* loop requires approximately 2.5 times the height of the loop (or the width of the spacer) to complete, so it is easy to estimate the approximate length to spin. Because the spinning and plying proceed sequentially – spin strand one, spin strand two, then ply the two lengths together – there is scope for adding a length of previously coloured fibre as spinning progresses. Close scrutiny typically reveals a ‘barber’s pole’ spiral in the two singles of the string where a coloured length has been inserted. Therefore the practice of dyeing the fibre prior to spinning is implied for bags in the sample where such splicing has occurred between colour sections; this technique is also extended to spinning one strand red or blue and plying with a natural strand (Figure 7). Unsurprisingly, the practice is most evident for the Yuri sample, particularly when the colours used are the bright blue and scarlet red, both colours that appear to be introduced dyes. The Yuri sample is also remarkable for the considerable use of large blocks of colour.


Figure 7. String bag with splice between undyed and red dye strands (PM E2649, Yuri, Fongwinam, Craig, 1968).

If the fibre-steeping process is followed, the dyed supply may then be used in several ways:

- Spun into a single colour length convenient for looping (approximately four to five metres; Mackenzie 1991: 76) and used for stripes, blocks, checker board or step patterns.
- Spun into a length comprising natural and dyed portions for ‘spot’ patterns and shorter stripes.

In either case, if the working string proves of insufficient length for the required pattern, more fibre may be easily spun into the length.

Where small quantities of dyed string were used, direct application of colourant to spun string (staining) in pre-planned lengths just prior to looping would have been common especially where modification of pigment source was relatively unnecessary such as in the use of berries. In such cases there is no overlap between the colour and the undyed portion of the string. However, the *spot* patterns (see below), which are really small blocks of colour involving several discrete loops, are a result of colour application that occurs at an even later stage in the bag creation – that of applying the colour during the looping process. The colour from berries, leaves or flower petals are suitable to be applied directly to the string in such a manner. The size or length of the dyed section is regulated by the planned program and the amount of colourant ready at hand.

Application of dye to finished bag

Several instances of application involving the rubbing of pigment-containing material onto a finished bag were found in the sample from the Abau-DR settlements of Wagu and Ambremaki. In these cases the technique appears to have been used to copy *step-patterns*, patterns commonly crafted by members of neighbouring Namie and Abau communities who worked the patterns into the fabric of the bag by looping the dyed string. In most cases, however this applied method is used to make *spots* of colour and to a lesser extent *stripes*. The applied method is easily differentiated from the looped one because it typically leaves the upper and lower linkages absent of colour (Figure 8).

Figure 8. String bag with *applied stripes.* (PM E11619, Abau, Wagu, Gerrits, 1969).

Factors affecting the colouration

There are several factors that may affect the hue, shade or strength of the colourant. First, is the base colour of the processed bast fibre and this varies according to the range of plants sourced. Powell (1976: 169) records 31 plant sources for string in New Guinea, seven of which are exclusively used in the construction of string bags. MacKenzie (1991: 69) lists ten sources for string bag fibre. Most commonly reported are *Phaleria macrocarpa* for the Border Mountains and *Gnetum gnemon* for the lowlands, additional sources may include the Paper mulberry (*Broussenetia papyrifera*) and various nettle plants (*Urticaceae*) (Julillerat undated; Kelm & Kelm 1980; 178; MacKenzie 1982 a & b; 1991: 67-68). In the neighbouring highlands of central New Guinea a significant number of *Ficus* spp are used and it is likely that several *Ficus* spp were also used in the upper Sepik basin and Border Mountains (Hyndman undated; MacKenzie 1991: 69). According to MacKenzie the base colours of fibre from such species can range from white (*Gnetum gnemon)* through yellowish, green, rusty red and even blue.

Colour will vary also according to how the bast is processed. Kelm & Kelm (1980: 178), for example, record that in the Yellow River area the *Gnetum gnemon* bark is only pounded after which the fibre is separated and dried for the process of spinning, while on the other hand another tree the Ak term as *autai* must be left immersed in water for one week until some fermentation has taken place before it can be softened by pounding, then separated and dried for spinning. In terms of the latter material, an important factor would be the fermentation and the decomposition of other plant material, such as leaves, that had been in the water prior to the bast fibre. For *Ficus* spp the processing can be different again. For example, MacKenzie (1991: 73) describes the Telefolmin of central New Guinea using embers to heat the saplings to enable the removal of the inner bark. The bast fibres are then placed on a smoking rack above a hearth to dry out overnight prior to processing. The first technique would result in tannins being absorbed into the fibre and the second in some carbonisation and both would render the fibre darker than that associated with the processing of bark from *Gnetum gnemon.*

In terms of variation in the pigments themselves, as discussed above, ripeness of fruit as well as stage of growth are important factors. Fugitiveness is also important as some pigments are volatile and change considerably over a relatively short period. Most flowers and seed capsules are likely to be fugitive or unstable, particularly to light. The yellows, while fairly stable, tend to fade to tan, and greens fade towards yellow. Reds fade to tan or light orange, which is particularly evident for string coloured with *Bixa*. The blues and purples fade to grey, which is often evident for pigment derived from the berries of *Cypholophus latifolius*.

On the other hand, some colours remain relatively unchanged through time. Factors such as the accumulation of mineral salts an important in this regard and this varies according to the nature of the soil in which the plant has grown. For example, aluminium is variably accumulated by *Melastoma* spp (Watanabe & Osaki 2002). In such cases the aluminium salt acts as a mordant to increase the stability of the colour derived from the roots, making it less susceptible to fading in sunlight and therefore more vibrant over a bag's duration.

A relatively bright pink-red that has mostly maintained its colour vibrancy is present on bags in the Namie and Abau samples and many of the bags with this colour were collected in the 1960s (Figure 9). The pink-reds appear a little too vibrant to have been extracted from natural sources; however pinks derived from the roots of *Melastoma malabathricum* maintain their colour.

Figure 9. String bag with pink-red stripes (Berlin VI 49784, Abau, Buna, Craig, 1968).

Pigments with a high tannin component are also likely to remain constant. Hence many of the brown and red-brown colours on bags in the collections, colours more likely to be produced with tannin-rich pigments, show little sign of fading.

Finally the use of adjunct substances can alter colour considerably. Unlike protein fibres, for example wool or silk, bast fibre can be treated with alkaline substances. As discussed above, with the addition of alkaline substances such as ash, or lime produced from decomposed limestone or by crushing and burning shells, yellows from the rhizomes of turmeric can turn orange and orange-red, and yellows and pinks from the root of *Morinda citrifolia* chang to red or red-brown (Figure 10). An increase in acidity will also affect colour. Therefore pigments, other than those recorded as being modified with such substances, may have provided a greater range of colours because of such reactions. For example, fruits and berries being blue to black when ripe and leaves with red pigmentation (e.g. Coleus) have the colour principle anthocyanin. This compound will change from blue to red or red to yellow in increasingly acidic conditions, or red to blue or blue to green with increased alkalinity. Acidity may vary naturally but acid may also be intentionally introduced as it is easily obtained from species of citrus.

Figure 10. Image showing trial colour modifications using turmeric. In the background left to right: turmeric made into a paste with water, rubbed on excess rinsed off; turmeric plus ash, paste rubbed on, excess rinsed off; turmeric plus water, soaked in ash water, rinsed; turmeric, water plus iron salt, soaked, rinsed; turmeric plus powdered charcoal, water, soaked, rinsed. In the foreground: turmeric mixed with lime. Trial and photo Jill Bolton.

Working the Patterns

Other than the aforementioned *step* technique and some *spot* techniques the patterns involve the alternation of plain and coloured string whilst looping the bag. The kinds of effects that have been achieved are very much to do with either the choice or sequence of looping patterns used, or the way the pigment was worked into the string as the looping progressed. These patterns range from a simple arrangement of *horizontal stripes* involving one or more colours; *step* arrangements; horizontal arrangements of large rectangular *blocks*; *checker-board* or *check and stripe* patterns; or sequences of *spots* (small rectangles) worked against a plain background. Looping usually proceeds from left to right, so the piece must be flipped over when reversing the course of the pattern, as is done when working a mouthband or strap.

Stripes

Stripes are the most simple and common pattern elements. They can be achieved with the full range of looping techniques found across the two regions and are often part of program involving other pattern elements. *Horizontal stripes* are achieved by splicing in a colour and looping until it runs out, then splicing in more of the same or another colour or applying additional colour to the working string. This results in both incomplete and complete circuits. The striping can involve regular or irregular vertical spacing, and sometimes can be different on each face of the bag. *Stripes* also occur as relatively short sections of colour that act as solitary or irregular occasional effects (Figure 11).

A series of *stripes*, whether it be with regular or irregular spacing, may be a single colour, or composed of several colours (Figure 12). Also they may be used to form a repeating sequence, e.g. blue/red/blue with plain rows between (Figure 14a).

Figure 11. String bag with a series of occasional irregular stripes of several colours (Berlin VI 49929, Abau, Hogru, Craig, 1969).

Figure 12. String bag with a series of regular spaced stripes of a single colour (PM E2598, Abau, Bisiaburu, Craig, 1968).

Stripes can also be made to run vertically. This is achieved when the bag is constructed as a narrow panel, which is then folded and secured along the side edges, a technique commonly used for small bags in the Border Mountains. In such cases the stripes are started or completed at the edge that forms the mouth of the bag when eventually completed. This alternative method of working stripes often results in vertical stripes that are different on either face (Figure 13). Although the piece is worked flat, this requires attention to be paid to the intended position of the fold as the stripes are looped prior to folding, thus the stripes are worked to the fold, then are worked in reverse back to the edge.

Blocks

Some bags have large rectangular *blocks* of alternative colour worked side by side (Figures 14a & 14b**)**. To achieve this, a block is worked with the looping going backwards and forwards, the looper flipping the work at each return. On its completion the next colour block is worked in a similar fashion, following on from the previous block and simultaneously completing a vertical join between the two (Figure 15).

Figure 13. Image showing both faces of string bag with vertical stripes (Vienna 148888, Yuri, Kambriap, Peter, late1960s-early 1970s).

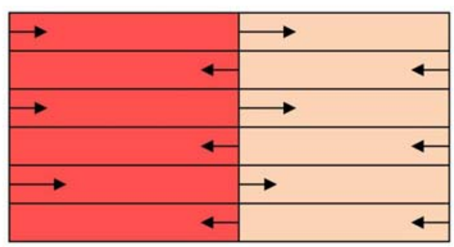

Figure 14b. Working of *block* pattern, vertical join. Arrows indicate direction of looping, right to left arrow indicates a "flipped" row .

Figure. 14a. String bag with *block* pattern and *stripes* (Vienna 148.889,Yuri, Kambriap, Peter, late 1960s-early 1970s).

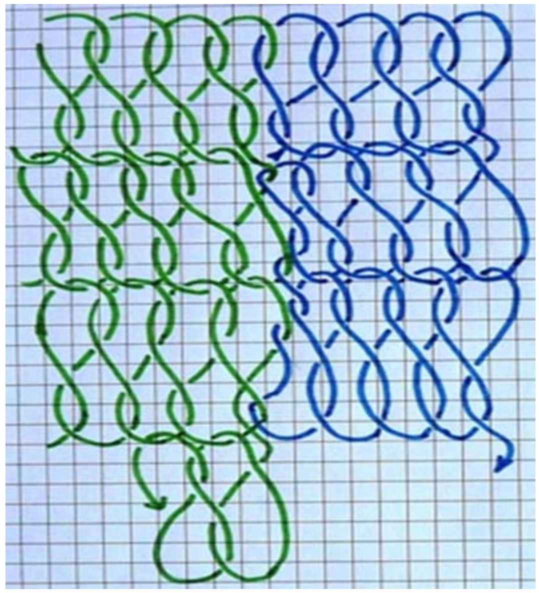

Figure 15. Diagram showing the working method for a vertical join used for both *block* and *step* patterns.

The *blocks* vary considerably in proportion of loops to rows, and also number of loops in adjacent blocks and are often separated and combined with other patterns. Like *stripes, blocks* can also be achieved with other looping techniques, although the *figure-eight* looping method is the one preferred.

Step patterns

Step-patterns require the use of several lengths of differently coloured string at one time, the *stripes* being worked simultaneously and alternately, and the steps worked in narrow discontinuous blocks, similarly linking to the next colour as the looping progresses (Figures 15 & 16a & 16b). These stepped stripes are usually three to four loops wide in their vertical expression and the typical *step* pattern has the number of loops in the horizontal stripe forming a space equivalent to that of the rows in the vertical section. This can be varied by adding extra loops in the horizontal sections – producing a *stripe* and *step* – or by a variation in the number of loops used for the vertical. The horizontal components are typically separated by an odd number of rows of the vertical component, in an order where the longer horizontal stripe can be worked from left to right in the normal fashion. The *twisted half-hitch* is commonly used for such staggered techniques because it best preserves the distinction between the colours. In doing so this loop technique results in the sloping of the vertical section (Bolton & Fyfe 2009: 14).

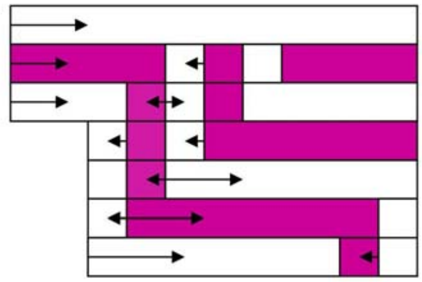

Figure 16b. Working of regular *step* pattern. Right to left arrows indicate a “flipped” row.

Figure 16a. String bag with regular *step* pattern (Leiden 4477-325, Namie, Mukudami, Craig, 1969).

The coloured string alternates with an undyed length and where more than one colour is present it is usually worked into a separate band of patterning.

The final *step*-based pattern is the *step and return*. It can be made to work as a horizontal or vertical sequence and in the latter is often combined with a series of *stripe and step* patterns (Figure 17a & 17b). For this pattern there is only one vertical block row between the long sections of the pattern. In order to work the small block and have the string at the appropriate place to work the reverse stripe, the string has to be taken to the position indicated by the curved arrow (Figure 17b). Alternatively, the string can be looped through the bottoms of the loops or running it over them back to the first loop in the block.

Figure 17a. String bag with a vertically arranged *step and return* pattern (PM 11621, Abau, Wiro, Gerrits, 1969).

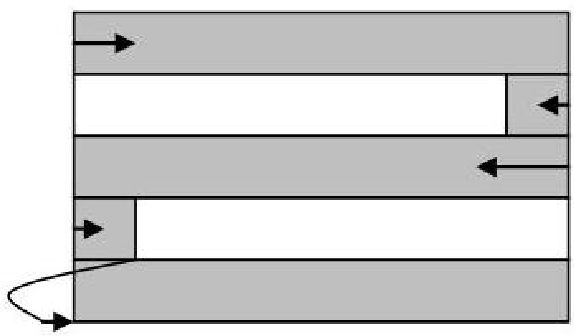

Figure 17b. Working of the *step and return* pattern.

In some cases *stripe and step* and *step and return* patterns are applied or partially applied by pressing the pigment onto the bag surface after looping as noted above. The pattern components are sometimes rendered in a somewhat random manner as well as being accompanied by arbitrary linear elements (Figure 18). These are likely to be the product of individuals that have yet to fully master the techniques associated with the looped *step* pattern.

Figure 18. String bag with an applied *step and return* pattern (PM 11618, Abau, Wagu, Gerrits, 1969).

Checker-board and other check patterns

Checker-board patterns are worked in a more sophisticated double spiral arrangement according to which two colours are worked simultaneously and alternately. One colour is worked to the point where the colour change is needed, the second colour on the row below is worked to a similar position, at which point the lower colour is linked into the row above and the top row colour drops down to the lower position (Figure 19). A block is then worked on the top row, followed by its counterpart on the lower row; the exchange is then performed again. These not only result in a *regular checker-board* pattern, but also *checker-board* patterns where the second two rows have been looped with the colours reversed (white on top, pink below) which results in a *regular reflected checker-board* pattern of two rows (Figures 20a, 20b & 20c).

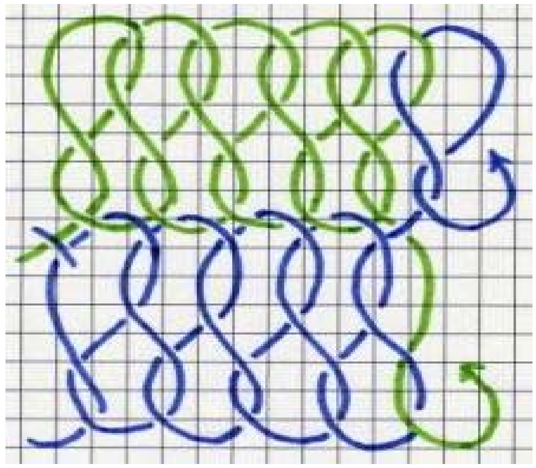

Figure 19. Diagram showing the colour exchange method for check patterns.

Figure 20a. String bag with *regular* and *regular reflected checker-board* pattern (Sydney E64305, Abau, Bisiaburu, Craig, 1968).

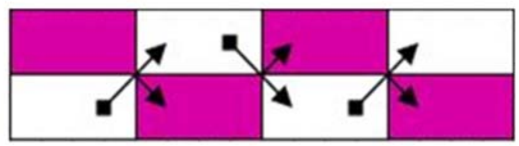

Figure 20b. Colour blocks forming *regular checker-board* pattern.

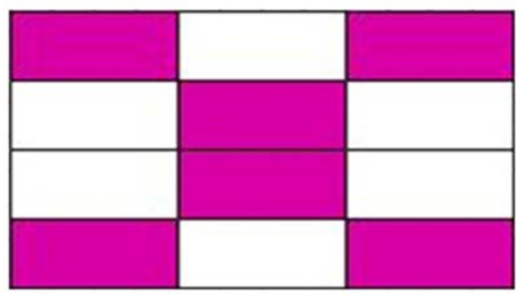

Figure 20c. Colour blocks forming *reflected regular checker-board* pattern.

Blocks may be made as short or long as the maker desires and some variations use a *regular spaced horizontal sequence of stripes alternating with blocks of shorter sections of colour exchanges* that form an intervening checker-board pattern (Figures 21a & 21b). These shorter sections consist of series of three-loop exchanges. In such circumstances the upper row must be completed first in order that the lower row can be linked to it. Upper and lower blocks are consequently the same number of loops, but allow for variations within the pattern.

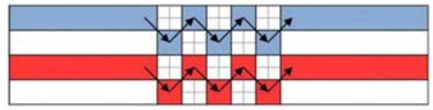

Figure 21b. Working of a pattern of*regular spaced horizontal sequence of stripes alternating with blocks of shorter sections of colour exchanges.*

Figure 21a. String bag with pattern of *regular spaced horizontal sequence of stripes alternating with blocks of shorter sections of colour exchanges* (PM 7485, Busa, Rawei, Craig, 1968).

A further variation exists whereby each in a *regular spaced horizontal sequence of stripes* is *followed by a short exchange of colour*. The latter form a small square of colour alteration before another stripe begins following the same row. A vertical sequence of these regular alterations in the number of loops between exchange events provides a wave-like effect (Figures 24a & 24b).

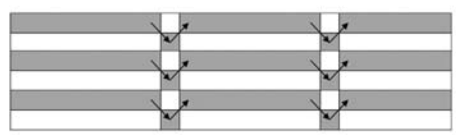

Figure 22b. Working of a pattern of *regular spaced horizontal sequence of stripes each followed by a short exchange of colour* .

Figure 22a. String bag with a pattern of *regular spaced horizontal sequence of stripes interchanged with a short exchange of colour* on the right side of panel (PM 6004, Awun, Dabrau, Kelm, early 1970s).

Spots or short dashes

Spots or *short dashes* are worked into a row either by splicing in pre-determined lengths of dyed fibre during spinning or by producing a dyed pre-spun length with spaces. The looping then proceeds as normal, with the *short blocks* of colour forming as the colour is reached; N.B. this pattern has no ‘exchange’ colour on rows above or below that can be called into play.

Figure 23. String bag with pattern composed of series of *spots* (Amsterdam 3947-10, Abau, Antibi, Craig, 1968). Photo Irene de Groot

The kinds of effects achieved have very much to do with either the choice and sequences of the looping patterns used, or the way the pigment was applied or incorporated into the string during the looping process. In many cases the *spots* are part of a larger design but there are examples where they make up a bag's entire pattern program (Figure 23).

The variations in *spot* patterns derive from the number of loops that form the spot and the number of loops of undyed string that separate them. The spots often form rows and these are either worked sequentially, in which case they may or may not align, or separated by an undyed row which essentially results in a *spotted stripe* effect.

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References.

Bolton, J. and A. Fyfe. 2009. *Knots, loops and braids: an examination of fibre craft techniques in the upper Sepik and Central New Guinea*. See www.uscngp.com/papers/knots-loops-braids

Craig, B. 1973. *Upper Sepik Field Diary. 1972-3.* Unpublished manuscript in possession of author.

Dean, J. 1999. *Wild Colour*. New York: Watson Guptil

Fyfe, A. and J. Bolton. Forthcoming a. *Technology, mobility and gender: interpreting variability in arrow and string bag characteristics in the Upper Sepik and Central New Guinea.*

Fyfe, A. and J. Bolton. Forthcoming b. *Inheritance or diffusion: an analysis of the spatial distributions of String bag patterns in the Border Mountains and upper Sepik basin.*

Gell, A. 1975. *Metamorphis of the Cassowaries: Umeda Society, Language and Ritual.* London: The Athlone Press, University of London.

Hill, R. 2001. Colourants used in the Material Culture of Papua New Guinea, in J. Kirby (ed.) *Dyes in History and Archaeology, Volumes 16/17.* London: Archetype Publication, pp. 54-62.

Hyndman, D. C. Undated. Collection notes held at the Papua New Guinea National Museum & Art Gallery.

Juillerat, B. Undated. *Notice de la base de gestion des collections: Collection Bernard Juillerat*. Collection notes held at the Museé du Quai Branly, Paris

Kelm, A. and H. Kelm. 1980. *Sago und Schwein. Ethnologie von Kwieftim und Abrau in Nordost-Neuguinea*. Wiesbaden: Franz Steiner Verlag.

MacKenzie, M. 1991. *Androgynous Objects: String bags and gender in central New Guinea.* Chur: Harwood Academic Publishers.

MacKenzie, M. 1982a. *To Sawonda:* Unpublished manuscript held at the South Australian Museum.

MacKenzie, M. 1982b. Collection notes held at the held at the Australian Museum, Sydney.

May, L. W. 1978. 'The Economic Uses and Associated Folklore of Ferns and Fern Allies' *Botanical Review* 44(4): 491-528.

Milliken, W. Undated *The Ethnobotany of the Yali*. Unpublished document available from the Royal Botanic Garden, Edinburgh (rbg-web2.rbge.org.uk/ethnobotany/Yali**)**

Morton, J. F. 1992. 'The Ocean-Going Noni, or Indian Mulberry (*Morinda citrifolia, Rubiaceae*) and Some of Its "Colorful" Relatives', *Economic Botany* 46(3): 241-256.

Muller K**.** 2004**.** *Biodiversity in New Guinea*. Unpublished document available at www.papuaweb.org

Powell, J. M. 1976. Ethnobotany, in K. Paijmans (ed.), *New Guinea vegetation*. Canberra: Commonwealth Scientific and Industrial Research Organization in association with Australian National University Press, pp. 106-183.

Pownall, G. 1976. *New Zealand Maori Arts and Crafts*. Wellington: Sevenseas Publishing.

Pryor, J. and C. Carr. 1995. Basketry of Northern California Indians: Interpreting Style Hierarchies, in C. Carr and J. E. Neitzel (eds), *Style, Society, and Person: Archaeology and Ethnographical Perspectives*. New York & London: Plenum, pp. 259-296.

Schetky, E. M (ed.) 1978 *Dye Plants and Dyeing −A Handbook: A Special Printing of Plants & Gardens Vol. 20, No. 3*. New York: Brooklyn Botanic Garden.

Varhdana, R. 2006. *Floristic Plants of the World.* New Delhi: Sarup & Son.

Von Reis, S. and F. J. Lipp. 1982. *New plant sources for drugs and foods from the New York Botanical Garden.* New York Botanical Garden. Herbarium. Cambridge: Harvard University Press.

Watanabe, T. and M. Osaki.2002. 'Role of organic acids in aluminum accumulation and plant growth in *Melastoma malabathricum'*. *Tree Physiology* 22: 785–792.

Wellige, I. 1996. Netztache, in G. Krüger (ed.) *Materialen zur Ausstellung: Sagohammer und Konservendose - Einblicke in die Kultur der Gargar in Neuguinea*. Göttingen: Institut und Sammlung für Völkerkunde der Universität Göttingen, pp. 60-61.