CAROLINE ISLAND BELT WEAVING

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THE OCCURRENCE and absence of loom weaving in the islands of the Pacific has long been a problem of interest to Oceanists. The authors, having at their disposal a small collection of fabrics of the finest type from Micronesia, here present a discussion of the general occurrence of loom weaving and fabric designing in the Pacific with the Caroline Islands as the focal point.

The basis of the technical part of our study is a collection of twenty-four narrow fabrics from the Caroline Islands, called belts for the sake of convenience, in the Museum of Anthropology at the University of California, and an heirloom belt from Ponape belonging to the senior author. While this is but a small sampling of such textiles known to exist in museums, they are indubitably an absolute norm for the types they represent.

Our paper is divided into three major sections. The first is a general consideration of the weaving craft in Oceania as viewed from the Caroline Island locale by Saul Riesenberg; the second is an analytical description of the fabrics and designs by A. H. Gayton. Both authors have contributed to the concluding section.

WEAVING IN OCEANIA

Loom weaving in the central Pacific is confined to the Caroline Archipelago and to some of the islands on the northern fringe of Melanesia. It is absent from the rest of Micronesia and Melanesia and, eastward, from all of Polynesia proper. But westward it occurs in virtually all of Indonesia. The Pacific distribution of weaving technique and loom type indicates that the basic instruments of the craft spread from a southeast Asiatic source through Indonesia into the Carolines and thence into northern Melanesia.

The Caroline Island loom is a horizontal tension backstrap loom. The warps are led in a continuous spiral around two beams, producing a ring-woven fabric. Attached to the ends of the breast beam (nearest the worker) is a strap which passes around the back of the weaver and against which she leans to tense the warps. Between the breast beam and its opposite, the warp beam, there are in sequence—in the upper plane of the warps—the heddle, shed roll, and lease rod. Adjunct tools are a bobbin carrying the weft, and the battening sword; in addition there may be pattern sticks and a brocading awl. This form of loom is one of the types found in parts of southeast Asia and much of Indonesia; it is the only form in the Pacific.[1]

In the Caroline Islands the loom is absent only on Palau and three or four Central Caroline Islands which obtain their woven articles in trade.[2] The two Polynesian outliers in the Carolines, Nukuoro and Kapingamarangi, provide a geographical link with the Polynesian outliers in Melanesia which also have or had the loom: Nuguria, Taku, Nukumanu, Ontong Java, Sikayana, and Tikopia. Elsewhere in Melanesia weaving occurs (or occurred) at Matema and Ndeni in the Santa Cruz group, at Santa Maria in the Banks Islands,[3] at Santo in the New Hebrides, west of this area in the St. Matthias group (Mussau, Emirau, Tench), and again in the Takar-Saar coasts of Netherlands New Guinea (the Jobi region, Sarmi, and the islands of Kumamba, Wakde, and Jamna)[4] (Figure 1).

Actual form of the loom parts is significant in consideration of the distribution of the loom throughout the area. In Indonesia ring-weaving is usually associated with cylindrical beams, in order to facilitate revolving the upper plane of the fabric forward as the work progresses beyond the reach of the weaver, whereas, for the most part, board-shaped beams are found with open-warp weaving. In the Pacific, however, exclusive use of cylindrical breast and warp beams occurs only in the Takar-Saar area, on the narrow-fabric loom of St. Matthias, on the Polynesian outliers Nukumanu and Taku, and on the Yap open-warp loom. Santa Cruz and Banks beams are cylindrical also, but are squared at the center where the warps pass around them. The warp beam is always cylindrical on the Polynesian outliers Nuguria and Ontong Java, and on the wide-fabric loom of St. Matthias, while on these islands the breast beams may be of this shape but also may be square at Nuguria, squarish at Ontong Java, and board-shaped at St.

1 There is one exception: the "money cloth" loom of Yap, on which excessively long warps (30-100 Klafter according to Müller) are horizontally stretched between breast and warp beams, and are supported by intervening bamboo trestles. The warp is in one plane (not a ring warp). As work progresses, the fabric is rolled up on the breast beam, the supports and opposite beam being moved forward as the warps become shorter. The finished cloth is rolled up in coconut leaves and tied with rope, the rolls being a form of currency. An identical type of loom is known in rural China and India (Little, 1902, p. 62; photographs from Klein and Reyerl, Madras).

2 Losap and Nama apparently never have had the loom (Krämer, 1935, p. 145; Kubary, 1895, p. 61; Finsch, 1914, p. 433). A number of other islands which formerly had the loom have given up weaving. Nauru, outside the Carolines, is said by Hambruch (1914, p. 81) to have had weaving, but Kayser (1917-18, p. 334) disproves this theory.

3 Rivers (1914, vol. 2, p. 379) suggests also that weaving was once present at Ureparapara and Rowa in the Banks Islands.

4 Sources for distribution of the loom: Ephraim, 1905, p. 58; Finsch, 1914, pp. 429-431, 440; Nevermann, 1938, p. 15; Parkinson, 1898, pp. 117, 118; Parkinson, 1907, pp. 544-548; Roth, 1918, p. 106; Wedgwood, 1927, p. 46.

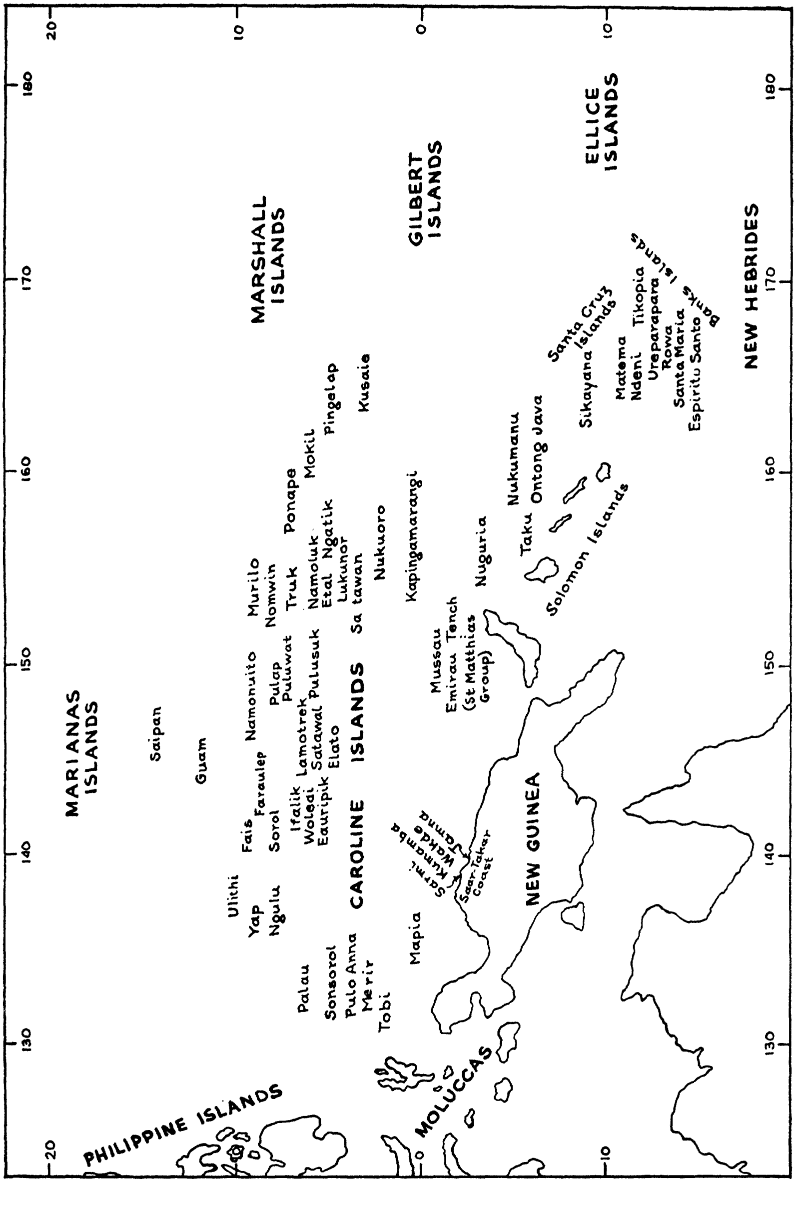


Fig. 1. Schematic map of the islands cited in the accompanying paper.

Matthias. The two beams may take either the cylindrical or square shape at Sikayana, cylindrical or board-shape on the Yap closed-warp loom. All these Pacific cases, except Yap, are Melanesian or on the Melanesian periphery.

The warp beam is either cylindrical or board-shaped, the breast beam board-shaped, on Ponape, Kusaie, Nukuoro, and Kapingamarangi. The last two islands may have also square breast beams, and in Kapingamarangi the warp beam may further be square or hexagonal.

The warp beam is board-shaped or square, the breast beam square, on Lukunor and Pulusuk. Lukunor sometimes has cylindrical or board-shaped breast beams. On Truk the beams are often both squarish, as they are on Namonuito.

Apart from these cases, all loom beams elsewhere in the Carolines are board-shaped.[5]

The lease rod may be single, in which case it is wound about by each warp in a complete turn. If a pair of lease rods is used, these are inserted under alternate opposing warps; the pair is then squeezed or tied together. (Either method holds the warps in firm separate position.) Both forms occur in Indonesia and on Kusaie, Ponape, Kapingamarangi, Lukunor, and Pulusuk—all islands in the eastern half of the Carolines. A combination of the two forms on the same loom occurs in the Central Carolines, on Woleai, Faraulep, and Elato, and possibly also on Fais, Sorol, and Lamotrek. Single lease rods occur in the remainder of the archipelago, as well as at Takar-Saar and St. Matthias. Elsewhere in Melanesia (Nuguria, Taku, Nukumanu, Ontong Java, Sikayana, Santa Cruz, Banks Islands) only the pair is found.

Swords (battens) are of two principal types: single-edge and double-edge. The former type is found almost exclusively in Indonesia and, with one exception (Sonsorol), in the western part of the Carolines as far as Elato and Lamotrek. Both forms occur on Lukunor and Kapingamarangi. The double-edge form occurs from Pulusuk-Puluwat eastwards, including Nukuoro, and in all the Melanesian

5 Sources for beam, lease rod, and sword types: Chinnery, 1925a, p. 79; Chinnery, 1925b, p. 200, pl. 42; Damm, 1938, pp. 170, 247, 322, figs. 142, 221, 247, 344, pl. 13; Damm and Sarfert, 1935, figs. 195, 196; Eilers, 1934, pp. 109, 111, 258, figs. 45, 70, 152, pl. 6; Eilers, 1935, pp. 291, 405, figs. 106, 204; Eilers, 1936, pp. 189, 190, fig. 145, pl. 8; Ephraim, 1905, pp. 59, 60, fig. 53; Finsch, 1893, p. 221; Girschner, 1912, p. 158; Graebner, 1909, pp. 105, 123, fig. 53; Hambruch and Eilers, 1936, p. 383, figs. 174, 175; Hiroa, 1950, p. 158, fig. 97; Krämer, 1932, p. 198, fig. 169, pls. 19, 21; Krämer, 1935, pp. 62, 266, fig. 97, pl. 20; Krämer, 1937, figs. 45, 46, 49, 114, 171, pls. 4, 11, 17; Kubary, 1895, pp. 60, 95, 109; Kubary, 1900, p. 128; Le Bar ms.; Müller, 1917, pp. 109, 110, 115, figs. 161, 165, pls. 30, 31; Nevermann, 1933, pp. 134, 135, figs. 85, 86, 89, 90, pl. 9; Nevermann, 1938, pp. 232-253, 294, 297, 300, 301; Parkinson, 1898, pp. 207, 208; Parkinson, 1907, fig. 98; Roth, 1918, pp. 96, 97, 102, 105, figs. 155-157, 165; Sarfert, 1919, fig. 73; Sarfert and Damm, 1929, pp. 174, 175, fig. 232; Schmeltz and Krause, 1881, pp. 326, 345, 346, 378.

islands for which information is available. In Lukunor, Kapingamarangi and Melanesia (Nuguria, Nukumanu, Ontong Java, Santa Cruz, Banks) the double-edge form often has only one point, the other end being squared off or provided with a handle. A keel-like ridge along the length of the sword is seen on specimens from Lukunor, Nukuoro, Kapingamarangi, Santa Cruz, and Banks Islands.

The bobbin is of the same type for most of the area being considered, and is quite like the netting needle ("shuttle") common throughout Oceania. But a form in which the body, around which the weft is wound, is left open or carries large perforations, occurs occasionally at Pulusuk, Nukuoro, and Kapingamarangi (Carolines) and Sikayana and Santa Cruz (Melanesia).

The warping bench is a special development peculiar to the Caroline Islands of Ponape, Kusaie, and Kapingamarangi. Its purpose is to support the vertical posts on which the warps are wound before they are transferred to the loom. In Ponape and Kusaie islands a flat-topped beam is mounted on posts or legs, while the Kapingamarangi form has low transverse feet. A rectangular board placed directly on the ground serves the same purpose in the St. Matthias group. Both the bench and the board type are found widely distributed in Indonesia. Elsewhere in Indonesia and in the Pacific the warping posts are driven into the ground, and in Santa Cruz the loom elements themselves (beams, heddle, and shed roll) function first as warping posts in the ground before being mounted as a loom, thus eliminating the duplicate sets of substitute posts. The measuring grid, which is associated with the warping bench on Ponape and Kusaie, occurs only there.[6]

Everywhere in the Oceanic weaving area warp threads run the full length of the fabric without changing color except for the special Carolinian style. If decoration occurs at all, striping is the usual form, and is achieved by knotting on a new color of yarn during the preparatory winding of the warps; the same color may be used for several successive complete revolutions of the warp. This is the type of weave we have called Class A herein (Figure 2, top). Warp stripes of varying widths are found in most of the Carolines, and at Takar-Saar and in St. Matthias. In Sikayana colored warp yarns are used singly, rather than in

6 Sources for perforated bobbins and warping bench: Eilers, 1934, p. 111, figs. 71, 154; Ephraim, 1905, fig. 51; Finsch, 1893, pp. 474, 475; Finsch, 1914, pp. 431, 435; Hambruch and Eilers, 1936, fig. 173; Hiroa, 1950, pp. 151-155, figs. 90-94; Nevermann, 1933, p. 132; Nevermann, 1938, pp. 239, 245, 251, 252; Roth, 1918, p. 96, figs. 155, 156; Sarfert, 1919, fig. 85; Schmeltz and Krause, 1881, pp. 279, 345.

Lesson (1839, p. 526) says that Pingelap cloths in their weaving, variety of design, and lively coloring were in no respect inferior to those of Kusaie; the art of weaving has long been extinct on Pingelap, and loom and fabrics are not described in detail in any source. But Lesson's statement suggests that the Kusaie-Ponape techniques were once practised there, which implies the presence of the warping bench and measuring grid.

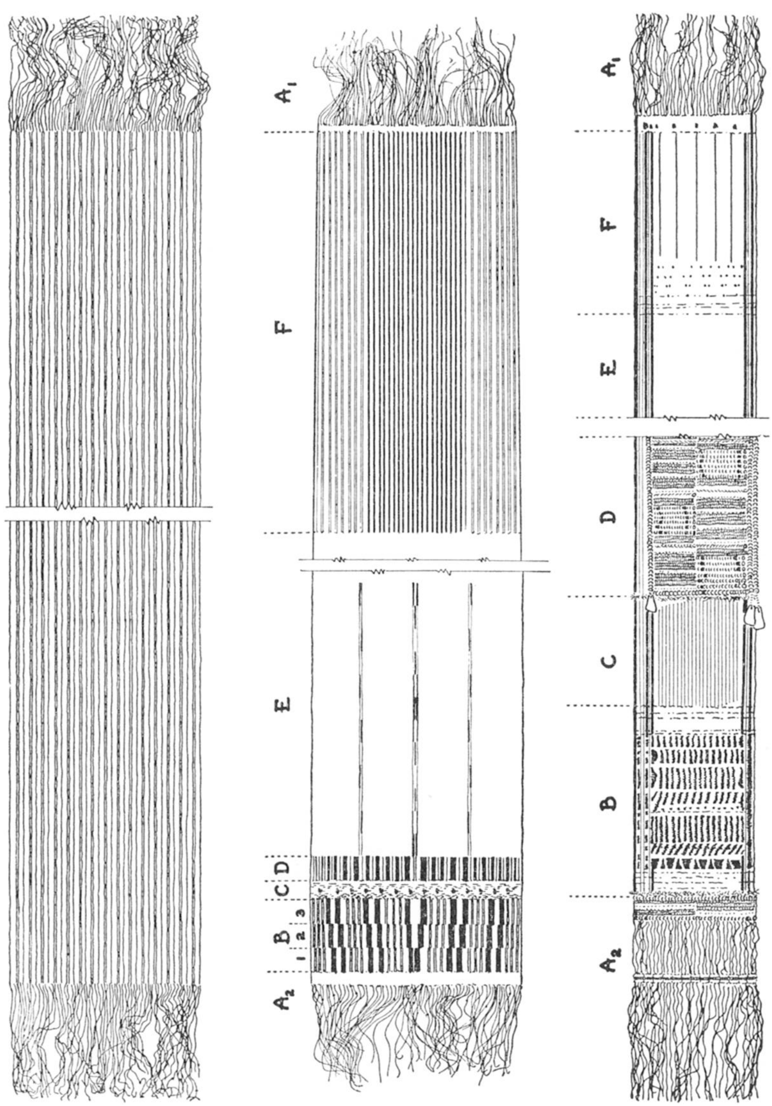


FIG. 2. Caroline Islands belts. *Top:* Class A, plain weave striped belts, Kusaie. *Center:* Class B, warp-knotted design belts, Kusaie. *Bottom:* Class C, bead encrusted belts, Ponape.

groups. Warp-striping is absent, however, in parts of the Southwestern Carolines (Tobi, Pulo Anna) and in two Central Caroline islands (Namonuito, Puluwat), as well as on Nukuoro, Kapingamarangi, and all of the Polynesian outliers in Melanesia.[7]

Incremental color changes within a warp length are used in an elementary fashion on Lukunor, Satawan, and Namoluk in the east Central Carolines. There a colored, striping warp may have a second color added to its end to create a change in the fringe portion. We call this Class Sub-B.[8]

Only on Kusaie and Ponape (Eastern Carolines) occur the weaves with knotted-in designs which we have called Class B (Figure 2, center). Here color changes are made at any point desired in the warp length, often resulting in variable design bands across the width of the fabric. Such bands occur nowhere else, although rudimentary forms of this technique appear on Lukunor, Satawan, and Namoluk in the Central Carolines.

The use of shell discs applied while weaving, as described below as Class C type, is apparently unique for Ponape (Figure 2, bottom; Plates 2, 3). On Truk red shell disc beads are sewed around the neck hole of the woven poncho; they are arranged in rows which may continue down the front of the garment, often branching into rows on either side. The discs are laid so they overlap like shingles, as in our Ponapian weaves.[9]

Pattern weaving, by means of floating warps over several wefts, is described below for the Ponape and Kusaie fabrics. This effect is achieved by pattern sticks

7 For Pulusuk and Sonsorol, Nevermann (1938, pp. 233, 239, 302) and Eilers (1935, p. 117) deny warp-striping, and none appears in any plates. But Schmeltz and Krause (1881, p. 304) mention stripes for Pulusuk, and Finsch (1914, p. 431) reports for Sonsorol stripes similar to those of Lord Howe (Ontong Java). Ontong Java and Nukumanu may formerly have had striped cloth (Sarfert and Damm, 1929, pp. 91, 176; Nevermann, 1938, p. 250). Another Polynesian outlier, Tikopia, is said by Finsch (1914, p. 440) to have had weaving like Woleai, which does have stripes. Finsch (1893, p. 585; 1914, p. 434) claims narrow white warp stripes formerly occurred on Kapingamarangi. No museum specimens or illustrations from any of these islands show such stripes, and the present authors do not include them in their historical reconstructions.

Sources for presence and absence of striping: Chinnery, 1925b, p. 198, pls. 41-43; Damm, 1938, pp. 23, 123, 170, 236, 321, figs. 141, 221, pls. 2, 4, 8, 12, 13, 22, 24, 32; Damm and Sarfert, 1935, pp. 42, 43, pls. 18, 19; Eilers, 1934, p. 112, pl. 7; Eilers, 1935, p. 291; Eilers, 1936, p. 221, pls. 3, 4; Finsch, 1893, p. 585; Finsch, 1914, pp. 432, 433, 438; Girschner, 1912, p. 159; Graebner, 1909, figs. 53, 54; Hiroa, 1950, p. 165; Krämer, 1932, p. 189, pls. 20-22; Krämer, 1935, pp. 62-66, 255, 265, pls. 6, 7; Krämer, 1937, pp. 76, 77, 247, 248, 340, 343, 345, pls. 6, 7, 12, 20, 22; Kubary, 1880, pp. 267-268; Müller, 1917, pl. 32; Nevermann, 1933, pp. 81, 137-139, figs. 85, 86, pl. 9; Nevermann, 1938, pp. 233-253; Parkinson, 1907, fig. 98; Sarfert and Damm, 1929, pp. 91, 176; Schmeltz and Krause, 1881, pp. 302-306.

8 Krämer, 1935, pp. 62-64, 66, pls. 6, 7; Kubary, 1880, p. 268.

9 Krämer, 1932, p. 92, pls. 1, 2, 6, 9.

on Kusaie, Ponape, Fais, in the Southwestern Carolines, and elsewhere. One or more heddles are used for the same purpose on Truk, Woleai, Lamotrek, Eauripik, and Ulithi, while these or some other means of selecting special sheds appear to be used in virtually all of the Carolines. Such devices are lacking on Yap, Nukuoro, and Kapingamarangi and apparently everywhere in Melanesia, with a concomitant lack of the technique.[10]

Brocading—the addition of extra wefts to form a decorative motif on the surface of a cloth—is not restricted to Ponape and Kusaie, though it is not a universal technique in the Carolines, being absent at least at Namonuito, Pulusuk, and Kapingamarangi. Usually the addition is made with aid of an awl (or an eyed-needle on Fais and Tobi), and the wefts are single threads just the width of the cloth. On Yap a bobbin is sometimes used and the extra weft continues from shed to shed; this is on ring-woven fabrics. Brocading does not occur outside of the Carolines; the only Polynesian outlier which practises it is Nukuoro, in the Carolines. Embroidery, which only superficially resembles brocade, is added to finished textiles on Tench in the St. Matthias group and at Santa Cruz.

In most Micronesian loom-made textiles the ratio of length to breadth is much closer than those analyzed in this paper.[11] The widest webs are found on Truk, where proportions of women's sarongs may be as low as 1.9 to 1. The men's breechclouts are almost as wide, being folded several times. Throughout

10 Sources for the presence and absence of pattern weaving and brocading (from authors' statements, inferences, and illustrations of looms and fabrics): Damm, 1938, pp. 23, 43, 170, 171, 236, 321, figs. 66-85, 141, 221, 344, pls. 8, 12, 13, 22, 32; Damm and Sarfert, 1935, pp. 43, 80, pls. 18, 19; Eilers, 1934, p. 112, pl. 7; Eilers, 1935, pp. 117, 152-154, 190, 290, 291, figs. 34, 202, 203, pl. 1; Eilers, 1936, pp. 140, 189, 221, pls. 3, 4; Ephraim, 1905, fig. 53; Finsch, 1893, p. 585; Finsch, 1914, pp. 432, 433, 440; Graebner, 1909, figs. 14, 53; Hambruch and Eilers, 1936, figs. 68-92; Hiroa, 1950, p. 165; Krämer, 1932, pp. 189-193, 214, fig. 169, pls. 20-22; Krämer, 1935, pp. 61-66, 255, fig. 97, pls. 6, 7, 9; Krämer, 1937, pp. 76-82, 247-250, 340-344, figs. 17, 49, 115, 171, pls. 6, 7, 12, 20; Kubary, 1895, pp. 60, 95, 109; Müller, 1917, pp. 114-117, pls. 32, 33; Nevermann, 1933, p. 139; Nevermann, 1938, pp. 233-253, 302; Parkinson, 1907, p. 343; Roth, 1918, fig. 171; Sarfert, 1919, pp. 185, 186, 192, 193, pl. 26 (2); Sarfert and Damm, 1929, p. 176; Schmeltz and Krause, 1881, pp. 303-305, 357, 358, 381, 390, 393.

11 Sources for length-breadth ratios: Chinnery, 1925a, p. 79; Chinnery, 1925b, p. 196; Christian, 1899, p. 397; Damm, 1938, pls. 2, 8, 12, 22, 32; Damm and Sarfert, 1935, pp. 42, 43, pls. 18, 19; Eilers, 1934, fig. 70, pl. 7; Eilers, 1935, pl. 1; Eilers, 1936, pp. 140, 221; Finsch, 1893, pp. 222, 481, 529, 583, 591; Finsch, 1914, pp. 431-439; Graebner, 1909, fig. 54; Hambruch and Eilers, 1936, figs. 68-92; Hiroa, 1950, pp. 151, 154, 165; Krämer, 1932, pp. 190-194; Krämer 1935, pls. 7, 20, 22; Krämer, 1937, pp. 249, 250, pls. 6, 7, 26; Kubary, 1880, p. 267; Kubary, 1895, pp. 91, 109; Müller, 1917, pl. 32; Nevermann, 1933, p. 81, figs. 85, 86, 89; Parkinson, 1897, pp. 117, 118; Parkinson, 1907, p. 544; Sarfert, 1919, pls. 29-34; Sarfert and Damm, 1929, figs. 51, 52; Sarfert and Damm, 1931, pl. 57; Schmeltz and Krause, 1881, pp. 118, 278, 291, 292, 302, 303, 335, 357, 381, 382, 393.

the Central Carolines garments run not much narrower than this, the narrowest occuring on Woleai, where the range is 3.7:1 to 4.5:1. On Yap, to the west, slightly narrower fabrics are found, the range going to 5.3:1. Similar proportions are found, for sarongs only, in the Polynesian outliers and at St. Matthias. Narrow breechclouts occur in the Southwestern Carolines, the proportions being as much as 11.7:1 on Tobi and 16:1 on Sonsorol (in these islands the woman's sarong is a plaited, not woven, article). On Nukuoro, the Polynesian outlier in the Carolines, the breechclout is about 9:1 in its length-breadth ratio, and a similar figure seems to hold for the men's garments in other Polynesian outliers in Melanesia: the proportion for Nukumanu, for example, is 10.8:1. At Santa Cruz the range is great for men's garments (3:1 to 13:1), while in the St. Matthias group, in contrast to sarongs, men's belts are extremely narrow (16:1 to 31:1). Kusaie proportions run from 6.9:1 to 10.3:1, and those of Ponape are 10.6:1 to 19.2:1.

Everywhere in the Carolines, with two exceptions, weaving is a feminine task. In one of the two Polynesian islands, Kapingamarangi, it is done by men. In Yap either sex may make ordinary cloth on the backstrap, ring-warped loom, but only men work on the extended loom; no doubt this is in response to prestige patterns associated with money cloth. Where information is available, weaving is a male prerogative in the Polynesian outliers in Melanesia and on Santa Cruz. But in the St. Matthias group and on Sikayana the women weave. Weaving by men is extremely rare in Indonesia.[12]

TEXTILE AND DESIGN ANALYSIS

The total effect of a textile, giving it a quality called style, has three major components: (1) the nature of the *fiber* used in the yarns, (2) the *color* of these yarns, and (3) the *weave* or structuring of the yarns into a fabric web. All these interplay in an effect of dullness or glossiness in the yarn surface, the lack or elaboration of color as introduced in design and more or less controlled by the mechanics of the weave, and the textural quality of the weave itself—smooth, perhaps, or bumpy—in the criss-crossing of the warps and wefts.

12 Sources for sex of weaver: Chinnery, 1925a, pl. 55; Chinnery, 1925b, pls. 41-43; Damm, 1938, pp. 247, 321, pl. 13; Damm and Sarfert, 1935, pp. 79, 145; Eilers, 1934, pp. 68, 109, 257, 258; Eilers, 1935, pp. 152, 395; Eilers, 1936, pp. 189, 233; Finsch, 1893, p. 473; Finsch, 1914, pp. 432, 438, 439; Girschner, 1912, p. 131; Hambruch and Eilers, 1936, p. 383; Hiroa, 1950, p. 148; Krämer, 1932, fig. 169; Krämer, 1935, pl. 20; Krämer, 1937, pp. 74, 247, 342, 343, fig. 114; Kubary, 1880, p. 267; Kubary, 1895, p. 95; Kubary, 1900, pp. 107, 127; Müller, 1917, pp. 109, 115; Nevermann, 1933, p. 134; Nevermann, 1938, p. 278; Parkinson, 1898, pp. 194, 195, 207, 208; Roth, 1918, p. 101, fig. 157; Sarfert and Damm, 1929, p. 173.

The native fiber used in the belts here considered is exclusively from a plantain of the general type known as "Manila hemp" (*Musa textilis*). The natural pale straw-colored fibers when formed into yarn have a high sheen and a springy flexibility; cut ends or fringing will tend to curl collectively and want their own way if not bound by weft crossings.

Two introduced fibers, cotton and wool, appear in limited quantity as decorative yarns. Cotton, apparently indigo-dyed, is used for brocading. In one Kusaien fragment red wool is used for brocading; red and yellow wool are similarly used in the Ponapean belt. The Ponapean belt, which has a bold red fringe of wool, clearly shows the yarns to have been raveled from red wool cloth.[13]

In the matter of color there is a greater range than in fiber. But which or how many of the colors used in the collection at hand are of native dyes or of European source, it is impossible to tell without laboratory analysis. These colors are probably wholly native: a rust red, a yellow, and an off or untrue black.[14] Other colors, e.g., blue, purple, green, pure red, and of course, the flannel red, all look suspiciously artificial or aniline. However, inasmuch as dyes were highly developed in the Indonesian area, diffusion of dye knowledge into Micronesia may have followed other elements of the weaver's art from that direction.

The weaves in the belts are simple enough technically, being limited to plain weave (over 1, under 1), pattern weave (warp-float), and brocade (extra weft). The plain weave is warp-face—wherein the warp elements greatly outnumber the wefts—and composes roughly ninety percent of all the fabrics. The use of pattern and brocade weaves is extremely limited in Kusaie and Ponape, although on the latter island fairly complex motifs have been rendered in brocade.

While even within this not great range of fibers, colors, and weaves, permutations of the possibilities could evolve complexly styled and varied fabrics, the Caroline Islanders did not extend their textile art in that direction. The unique styles of Kusaie and Ponape mainly result from exploitation of only two processes: knotting of warp lengths to produce color variation (a pre-weaving process), and adding beads onto a brocading weft. Both features, exceptional in weaving procedures, have been carried to a point of virtuosity.

The Caroline Island belts group into three style categories: Class A, plain

13 Raveling a foreign cloth to obtain the valued yarn for reweaving in accordance with local styles is not unusual; for example, this was done by Late Kingdom Egyptian weavers, the Ashanti, the Navaho.

14 Dye materials and methods are described in Christian, 1899, p. 158; Finsch, 1893, p. 474; Sarfert, 1919, pp. 175, 176. The red dye yields varied shades. Color range of *Musa textilis* (and probably other varieties) is from "practically white" through creams, yellows, ochres, to reds and browns (Weindling, 1947, Table 8, p. 50).

woven striped belts; Class B, plain, pattern, and brocade woven belts with knotted-in designs (Sub-B is a rudimentary variant, possibly proto-B), and Class C, belts basically similar to Class B, but having bead encrustation. While Class C is represented here by but one example, it is a well-known type characteristic of Ponape.[15]

The preparation of yarns, warping method, and loom set-up are essentially the same for all three types of Caroline Island belts. One description of these steps will serve as an introduction to all.

The yarn, prepared from split fibers of the banana,[16] is not spun. It is characteristic of this plantain fiber that it may be split longitudinally to an almost infinite degree, thus permitting yarns of extreme fineness to be made if so desired. Fiber lengths range around three feet; this is an estimate. The yarns in all the belts are made of what is nominally a single ply. Yet this "single" ply warp (or weft) is actually a group of four to six filaments slightly twisted together by rolling on the thigh and as a group knotted end to end to form a continuous yarn. Individual filaments in specimens examined were all of a fineness equal to or greater than No. 100 cotton sewing thread; the yarn itself varied from equivalents of No. 12 to No. 16.[17] Thus the yarn is not made by true spinning, which is a process of overlapping and spiralling individual fibers so tightly that they will not pull apart under tension.

The exact method of knotting the fiber lengths together, either to form yarnage or to change color in the warp yarn is not altogether clear. The extreme brittleness of the fibers makes it almost impossible to unflex the tiny, tightly compacted yarn knots. Analysis revealed at least four types: two may be incorrectly deduced or may be variants which occur in the Class A fabrics. The other two types also appear in Class A: one of these, analyzed by Krämer-Bannow, occurs in the Class B fabrics, and the other, analyzed by Gayton, is in the Class C belt from Ponape[18] (see Figure 3a).

The plantain yarns of the Carolines, like the hibiscus yarn of Kapingamarangi and other Micronesian islands, depend wholly on knotting to attain longitude.[19]

15 Examples are shown in Hambruch and Eilers, 1936, pp. 286-295, pl. I (3).

16 One of the *Musa,* perhaps *paradisica, textilis,* or *ticap;* several varieties grow in Oceania (Matthews, 1924, pp. 809-815; Nevermann, 1938, pp. 27-30).

17 Yarn diameters in ten Class A specimens were determined by Dwight Wallace, Preparator at the Museum of Anthropology, University of California. A vernier sliding caliper gave yarn sizes ranging from .3 to .35 mm, individual filaments as .1 mm.

18 Krämer-Bannow, in Sarfert, 1919, p. 174. The Ponapean knot is like that of Kapingamarangi (Hiroa, 1950, p. 150, fig. 89).

19 A common method wherever plantain fibers are used, e.g., in the Philippines (Minier, 1913, p. 285).

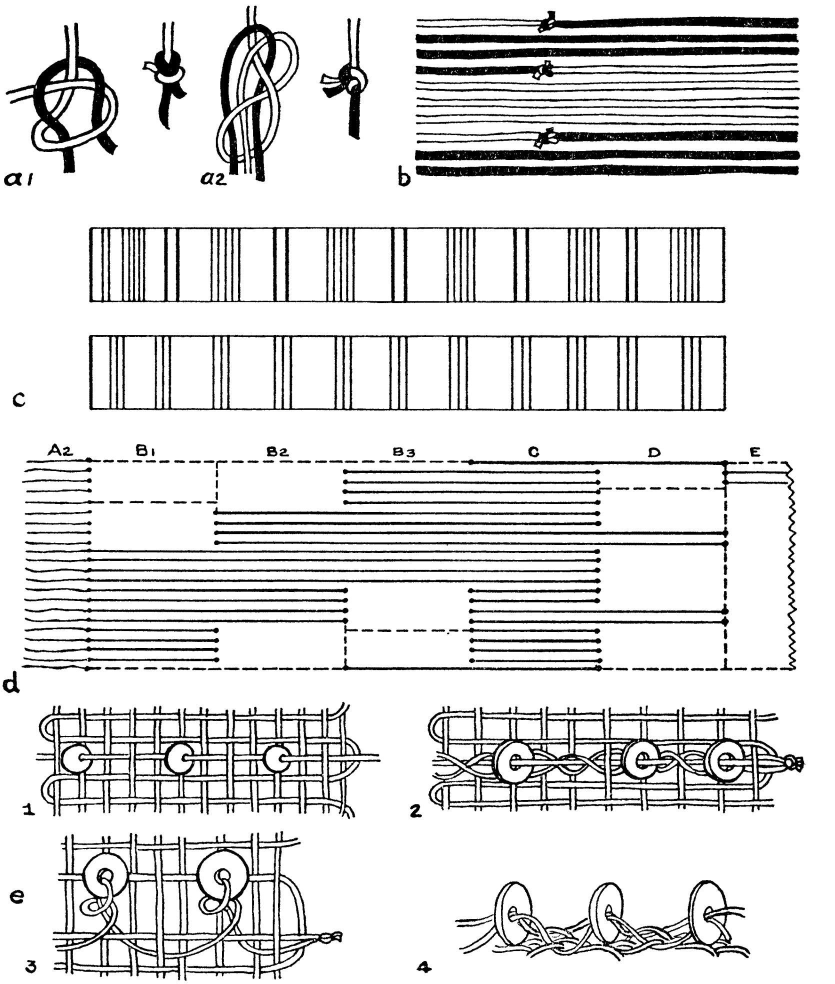


FIG. 3. Schematic drawings of techniques. *a1,* knot of Ponape; *a2,* knot of Kusaie (after Krämer-Bannow); *b,* knotting of warp stripes; *c,* examples of warp stripe groupings; *d,* yellow warp carried through several design sections; *e,* methods of adding beads: *1,* glass beads; *2,* shingled shell discs; *3,* vertical shell discs; *4,* shingled shell discs along warps.

It is this characteristic, plus a preference for warp-face weave, which gives the clue to the unique designing of Kusaie and Ponape belts.

The arrangement of warps on the loom is that known as "ring warp": a continuous strand of yarn passes successively around the front and back beams of the loom, progressing in a flattened spiral from one end of the beams toward the other until the desired width of the future cloth has been attained. The warps when so arranged have an upper and lower plane, and the weaving operation takes place on the upper one. As the warps close to the weaver are filled with weft, forming the web, the work is pulled toward the weaver; the whole band of warps, whether woven or as yet unwoven, slips around the loom beams as around rollers. When weaving has progressed to within a few inches of complete filling of the warps, the work ceases, and the unwoven warps, when cut at the center point, form fringes at each end of the belt.

Laying out of the warps (before being placed on the loom) is done on a warping bench in which short vertical posts substitute for the actual loom parts (warp beams, heddle, and shed roll; lease rod also sometimes) which eventually will be inserted in their proper positions in the warp ring.[20] The warp yarn is wound around and around the posts continuously, the incremental gain on each round being very small because of the fineness of the yarn.

If a striped warp is wanted (as in the Class A belts) it is necessary to make the color change in the continuous warp as it travels around the warp posts (Figure 3b). Thus, in the simplest way the knotting-in of color is established as a pre-planned designing technique. Any of these striped belts will show the line of knots for the color change, usually across one fringe, since weaving is started and finished so that the knotting-in of the colors will be in the unwoven warp section. A perfect example of this is specimen 11-198 in which the warps were never severed to open the ring-woven fabric.

The step from such a relatively unsophisticated stripe patterning to the complex ornament of Class B belts is only one of creative resourcefulness and finer control of a technique already realized in essence. It is even conceivable that the use of composite patterning grew out of errors in knotting for color stripes, or from a shortage of correctly colored yarns for full length stripes, resulting in an uncalculated polychrome pattern which suggested new design possibilities in the knotted-in technique.

Whatever the reason, the step between knotting-in colored stripes and the creation of complicated patterns by the same method, is exemplified by fabrics

20 This process has been fully described and illustrated elsewhere, though perhaps most effectively by Hiroa (1950, pp. 151-156). See also Sarfert, 1919, pp. 164, 167, 168.

from the Central Caroline islands, Lukunor, Satawan, and Namoluk. Lukunor and Satawan weavers place black stripes in a white background; at Namoluk they use red stripes as well. In the black stripes one or sometimes two successive warps change near the ends of the cloth to white, by means of knotting. This may occur several times in a single black stripe, and it is repeated in all the black stripes. In the laying out of the warps the ends of each of the short white threads are knotted to the black threads in approximately the same places on the turns around the warping posts. The section of the ring web which is left unwefted, and which later is to be cut to form the fringes when the cloth is opened out, lies in the middle of the white lengths. Thus, after cutting, there will appear towards both ends of the completed fabric, the occasional white threads in the black stripes, all of about the same length.[21] This intermediate style of knotted-in designing we have called Class Sub-B.

Class A: Plain Weave Striped Belts.[22] Since there is little distinction within this group—the chief variable being in color choice and grouping for stripes—overall description of technical features will suffice.

Lengths of the belts including fringe (total warp length) range from 42 inches to 54 inches, with the mode (4) falling at 50 inches, the mean at 48.6 inches. Widths vary much less: 6 or 7 inch widths tend to coincide with shorter and longer belts respectively, but between the four longest belts with a 7 inch width, and the three shortest with a 6 inch width, there is a scattering of width dimensions in relation to length. The variation in width is so slight as to appear constant when a whole group of belts is seen at once.

Fringe lengths show no clear relation to web length, longer belts often having shorter fringes than smaller belts. Since the length of the fringe is only de-

21 Description of Lukunor and Namoluk fabrics provided by Saul Riesenberg. In the Museum of Anthropology, University of California, five textiles of only "Caroline Islands" provenience have short lengths of yellow knotted into black stripes in such a way as to have the new color in each end and fringe of the web when cut open (specimen nos. 11-298, 11-304, 11-561, 11-562, 11-563).

22 Nineteen examples: Museum of Anthropology, University of California, specimen numbers: 11-186, 11-187, 11-189-202, 11-568 11-569, 11-571. The technical analysis of these fabrics was made by students in a graduate seminar directed by Gayton: Gottfried Berger, Frederick Blodgett, Richard Fiscus, Ralph Higbee, and Willis Kauffman. Their findings have been condensed for publication purposes.

The specimens, a gift of Mrs Phoebe A. Hearst, were acquired from a dealer in San Francisco in 1901 and assigned "Nukuor or Gilbert Islands" as provenience. There was no weaving in the Gilbert Islands, nor textiles of this type made in Nukuoro. Since the 19 pieces are identical in style with those of Kusaie as illustrated by Christian and Sarfert, we have had no hesitancy in assigning them to that provenience. (See Christian, 1889, pp. 394, 397, 398; Sarfert, 1919, pl. 16 (1), showing men's striped breechclouts.)

termined by the weaver's whim in ceasing to weave a solid web—leaving a space of unwoven warps to be cut as fringe—such irregularity is perhaps expectable. While webs of 45 or 46 inches have fringes of 8 or 6 inches, and webs of 38 and 37 inches have fringes of 4 and 7 inches, one of 40 inches has a 10 inch fringe, while its next neighbor in length, 41 inches, has but a 4 inch fringe. Two 45 inch belts have fringes of 8 and 5 inches; two of 38 inches, fringes of 9 and 4 inches. Owing to curling of the fibers, accuracy of fringe (and over-all) measurements is not perfect, but this variable factor is equal for all specimens.

Yarn counts, that is, proportion of warps to wefts per square inch, range from such extremes as 87:39, 70:24, making a "warp-face" fabric, to lower ratios of 50:38, 46:34, close enough to "square count" to be so classed. Nevertheless, the general tendency is toward a heavier proportion of warps to wefts, so that fifteen of the nineteen belts are warp-face fabrics, the four others approaching square count being the aberrations. Warp-face textiles are favored as belts in most weaving cultures because of their longitudinal strength. The weave lends itself to stripe decoration. Once the colored elements have been placed in their proper position in the warps, the weaver need not change weft color (since the wefts are obscured by the warps) and an attractive cloth results with a minimum of effort.

Ingenuity in arranging stripes of pleasing and diverse color is notable in the Class A Kusaien belts. The warp stripe patterns are remarkably similar in their general visual effect, yet variations in color sequence provide each piece with individuality. All color stripes are narrow; that is, only a few warps in width: no broad or bold banding effects are manifest. In all cases there is a background color: seventeen of these are the natural fiber, two a somber blackish brown, against which the several linear colors are grouped. The stripe groups often consist of threes, e.g., purple, orange, purple (11-189), and frequently alternate across the width of the fabric with a second grouping, e.g., rust, green rust, alternating with brown, yellow, red, yellow, brown (11-191). Thus variation is obtained in color by choice for the stripe units and their alternates, in a slight change in scale for individual stripe widths, and changes of scale for the alternate units. The background color also may come into play in these space-scale changes, as a narrow spacing between color stripes causes the background to appear as a "working" color in the total composition of the fabric. A belt (11-193) which uses only blue for its stripes gains interest through these regularized changes in its stripe groupings and their relative scale.

The colors which appear in the nineteen Class A belts are given here in the order of preference, with the number of occurrences in parenthesis: red (11), green (8), purple (7), orange (6), yellow (6), brown (6), blue (4), rust (2), white (1). The number of colors used in combination (against the backgrounds) are as follows: single units without alternates, 1 color, once; 2 colors, 6 times; 3 colors, 6 times; 4 colors, once. Color units in alternation: 1 and 3, once; 1 and 4, once; 2 and 3, once; 3 and 3, once. All striped units are arranged in color and spatial bisymmetry. Thus even the use of four colors may be extended into a wider group effect by a placement such as: green, yellow, brown, natural, brown, yellow, green, alternating with natural, brown, yellow, brown, natural, against a brown background (11-199). Other examples of such arrangements are of two or three colors, such as: rust, green, rust, natural, rust, green, rust, natural, alternating with brown, yellow, red, yellow, brown, against a natural background (11-191). Examples of color-space groupings are shown in Figure 3c.

Weft yarns are of natural, undyed fiber except in two with predominantly dark brown warps; these have matching brown weft.

Selvages, while having no special treatment in the way of extra warps, thicker warps, or of warp grouping in the return passage of the weft, are usually distinguished by color. In the nineteen belts at hand, fourteen have the edging warps in color; ten of these are red, with red especially placed there regardless of whether red is part of the color stripe groups or not. Other selvages colors are brown, green, or purple, placed there under the same conditions as red with regard to the total color scheme of the interior stripes.

Class B: Warp-Knotted Design Belts.[23] This class of belts is distinguished by several major and minor features. The overall designing is an arrangement of band-like sections across the width of the textile, though like all others, the composition is transversely bi-symmetrical. The number of bands is usually six though reduction to five occurs occasionally.[24] Within each section is a different pattern scheme accomplished primarily by color changes knotted in the warps or, secondarily, by changes of structural technique from plain weave to brocade or pattern weave. The fringe participates as one of the bands by always being of a distinctive color: rust red. Background color of all Class B belts is

23 Five examples: Museum of Anthropology, University of California, specimen numbers 11-182, 11-183, 11-185, 11-188, 11-567. One fragmentary specimen in the museum (11-567a) and one owned by Gayton have been taken into account, but not analyzed. Illustrations of Kusaie belts appear in Christian, 1899, p. 394, p. 397, and Sarfert, 1919, pls. 14 (1), 15 (2, 4), 26, 28-34. The Kusaie belts with warp-knotted designs are divided by A. Krämer into five sub-types according to variations in internal composition (in Sarfert, 1919, pp. 188-191, fig. 106, pls. 29-34). Our five specimens are all of the kíĕl sub-type, as are the two additional ones.

24 Seemingly a standard variation, since design section B is the one omitted in three examples: 11-183, 11-567a, and one in Sarfert, 1919, pl. 32 (16).

"black," or a deep brownish black approximating true black: the tone variation is slight. Size and proportions on the whole differ but little from the Class A belts, and like Class A, the belts with warp-knotted designs follow a closely standardized style while retaining individuality in minor color and scale changes.

A graphic description of the composition, nature of design units, and warp-knotting method is given in Figures 2, center, and 3d, based on specimen 11-188, which is exemplary of its type of Micronesian textile.

The layout of composition in this specimen is with the standard six bands: A1, A2, the red fringe (cut in halves); B, the tripartite band of symmetrically staggered rectangular units of black, white, brown, yellow; C, the warp base, yellow, brocaded in rust; D, a band of rectangular units, black, white, brown, yellow; E, the extenders of black, white, yellow, purple, into the black field of the major portion of the belt; and F, the striped section in black, white, red, yellow, purple. The segments of color in the designs are all rectilinear in form. Some are obviously so; others, because of their extreme narrowness and elongation, are not immediately recognizable as such.

The fine scale of the fiber yarn composing this belt (and others of its class) makes it appear as if the design bands crossing the fabric were constructed by knotting a new bit to each warp separately all across the belt. Such a method could be used regardless of whether the warp were of ring or open type and would simplify the designer's task from a visual point of view as she made the increments of warp on the frame posts. However, another method which obviates the necessity of so many knottings, but calls for greater imaginative preplanning and careful execution, was evidently preferred.

It so happens that in the various design bands or sections, segments, often minute, of the same color will recur one beyond another through two or more bands. Such color repetition may be but a few warp strands wide (Figure 3d). This conjunction or contiguity of a color, wherever the design units call for it, determines the method of knotting colors into the warps. The rule for warp construction, then, is this: that whenever a color is contiguous between design bands the knotted-in length of that color is sufficient to carry through the entire distance required, whether it be through two, three, or more bands. Simple as this may sound, in actuality the worker is dealing with constantly changing variables on every round of the warp as it is built up on the warping frame. The length of a color fiber to be knotted in may be exactly as it appears in the cross bands—a short unit. Or it may be an illusory length which because of the break-up of the design appears to stop at a band edge but in actuality runs through several sections.

To aid in the task of measuring lengths of warp to be added, a grid resembling a small ladder laid on its edge is fastened into the warping bench. This tool does no more than offer the worker a means of keeping the section lines of the design bands even across the warps of the future fabric. That is, the division lines where knots may (but do not always) occur are at right angles to the selvage lines. By analogy: it is as if the grid shows the worker 1, 2, 3 or more inch lengths so that equivalent yarn additions will be exact in length, but does not show *when* a length should be 1, 2, or 3 or more inches.[25] The creator of the warp-knotted designs, with the total composition of the textile in mind, determines the increment of color needed. Because of the transverse bi-symmetry of the composition, all the creative work is done when the center warp is reached; thereafter she may copy in reverse what she has already constructed on the bench posts. The number of knots in a Class B belt are in the thousands: an estimate for type specimen 11-188 gives around 4000, i.e., 8 in each of the 498 warps.

As an example of the knotting method Section A2, B, C, and D are shown in Figures 2, center, and 3d. At the boundary between A2 and B there is a row of knots in each warp because the color rust red of the fringe does not occur in the next section (B). Section B is a tripartite pattern made up of staggered rectangles using the colors black, white, brown, yellow. The three subdivisions of B are called B1, B2, B3 herein. Section C is a band with all yellow warps (upon which a superstructural weft of rust will be brocaded at the time of weaving). Section D is a band of black, white, brown, yellow rectangles (short broad stripes), a single variation of the triple pattern in Section B.

Thus yellow appears in three sub-sections and two whole sections contiguous to each other. To create the yellow areas the following lengths of yarn are knotted in:

Beginning at the boundary A2:B, and in variable order according to the needs of the design, yellow yarns may extend from B to B1, from B to B2, from B1 to D, from B2 to D, from B2 to E, from B3 to D or E, from C to E.

Since warps of Section C are entirely yellow, any warp that was not already yellow at the boundary B3:C will be changed to yellow by knotting-in. If yellow

25 Krämer-Bannow shows five ways in which the weaver determines variable long lengths of yarn, but does not point out the subjective creative problem in selecting which to use (in Sarfert, 1919, p. 179). There are at least ten different yarn measurements used in the patterning of type specimen 11-188.

rectangles in Section D are in line with yellows in B3 or B2 and B3, they will have been carried through C as part of C's all yellow warp. Whenever a yellow rectangle in D has not been supplied by this means, its warp will begin at B3:C and run through to E.

In Section D, of course, black, white, and brown will have to be knotted in anew (because of the all yellow Section C). But black is the basic color for Section E (the major portion of the belt), so all black additions will run at least to Section F (boundary E:F) where the stripes begin. However, black is the background color between the stripes, and in such linear areas the black warps must be continued to A, where they will be terminated by knotting on rust yarns for Section A (fringe).

Turning now to Section F, we find stripes of black (the background), white, yellow, purple, and rust. Black is cared for as mentioned above. White, yellow, and purple are knotted to Section E black (boundary E:F) and extend just the length of F. Rust, however, occurs in the fringe, so that whenever this color is wanted as a stripe, it too is knotted onto black for Section F but will carry on through the fringe section A, to terminate at the beginning of Section B.

In the specimen described (and in most others of Class B) the only cross-line in the belt where knots occur in every neighboring warp at the same point is at the division between Sections A and B, i.e., the end of the all-rust fringe and the beginning of a new color scheme in which rust does not occur.

The Class B belts, like most warp-face fabrics, have a minimal treatment of the wefts; this element functions only mechanically as a transverse binder, not as a decorative ingredient. The material, size, and quality of the wefts are exactly like the warps. Color is considered because the ratio of warps to wefts, plus the slick surface of the yarn, permits the wefts to show slightly between the warps if closely inspected. The dominating color of these belts is black, and black weft is used throughout save in the brocaded sections. In specimen 11-188 Section C with its all yellow warps has a yellow weft, evidently for the purpose of making a clear bold yellow background for the rust red brocading yarn. The depth of Section C is five-eighths of an inch, which required only twelve shots of the yellow weft; for all other sections, regardless of their warp color schemes, black wefts suffice.

Boundaries between design sections of the belts are emphasized by the addition of what is technically a weft element. This consists of a slender bunch of black fiber yarn laid in the shed at the cross-line of color-change knots. The structural weft continues normally; the extra weft is clipped off at both selvages.

The result is a transverse welt or repp which defines the design division and at the same time tends to camouflage slight irregularities in the line of knots. Considering the fineness and contrariness of the warp fibers, the crudeness of the measuring apparatus, and the distorting mechanical stress caused by battening on a ring-warp, it is remarkable that the cross lines of knots concur with the weft welts as perfectly as they do. In specimen 11-188 the thick extra wefts occur between Sections A, B, C, D, and E, but not between E, F, and A.

In these belts with warp-knotted designs the short section of brocade is a distinct technical innovation. Frequently, but not always, the rarer and probably imported cotton yarn in blue or red is used for imbrication. Our type belt has rust red banana fiber yarn as the brocading weft, presumably representing an older usage. All brocade designs in Class B belts are quite simple, comparable to Section C in specimen 11-188 shown in Figure 2, center.[26] The brocading weft is superstructural, inserted to raise a pattern without regard to the basic weft which continues its normal function. The brocade weft in 11-188 is slightly heavier than the basic weft, consisting of four to eight filaments (depending upon their coarseness or fineness) to compose a constant yarn thickness. Start and finish of the extra weft is merely a clipped end. The technique is the simplest type of brocading: the ornamental weft caught under two warps at the selvage and, following the shed line (but not within the shed) of the basic weft, floats across the warps or under them, moving from front to back surface of the cloth at the designer's will. At the opposite edge it is caught under two warps, turns for the next shed, passes under two selvage warps and again moves across the remaining warps in a series of front or back floats. The basic yellow weft continues normally over and under each warp in its own shed. The over and under surface brocading floats create a geometric pattern (obverse and reverse) of simple but pleasing repetitive units. While the center point of the pattern roughly coincides with the longitudinal axis of the fabric, bi-symmetry is not the aim of the brocaded design section. In example 11-188 the units "point" one way all across the cloth; easily, they could have been reversed at the center line to create an opposed half had the weaver so desired. However, the nature of the units themselves and the smallness of the section in which they figure scarcely interrupt the lineal balance of the total composition of the belt.

The final design section (F) of the Class B belts consists of narrow stripes

26 Both A. Krämer and E. Krämer-Bannow refer to this technique as "wattle work" (Sarfert, 1919, pp. 184, 193), a curious term for the structure involved: a two-face brocading with *extra* weft. That this extra weft was not put in after weaving is clear from its physical relationship with the basic weft and the selvage warps. Illustrations of brocade designs are shown in Sarfert, 1919, pp. 192, 193.

compactly aligned and lineally balanced in color and scale. Here occur two very minor technical changes still dependent upon warps as the decorative factor. In specimen 11-188 the weaver has taken advantage of one of the simplest devices for design in warp stripes: the repeated alternation of two colored warps so that, when woven, one color is on the surface at one shed, the opposite color on the surface at the next shed. This results in narrow horizontal areas of color succeeding each other lengthwise of the web. Adroit use of this technique in small scale bands of natural and black, and yellow and black, intersected by fine stripes of rust alone and black alone, make interesting borders to Section F. They fill the two outer quarters. The contrasting inner half of Section F is composed of thin stripes of black, natural, yellow, and purple—some single, some paired, all compact.

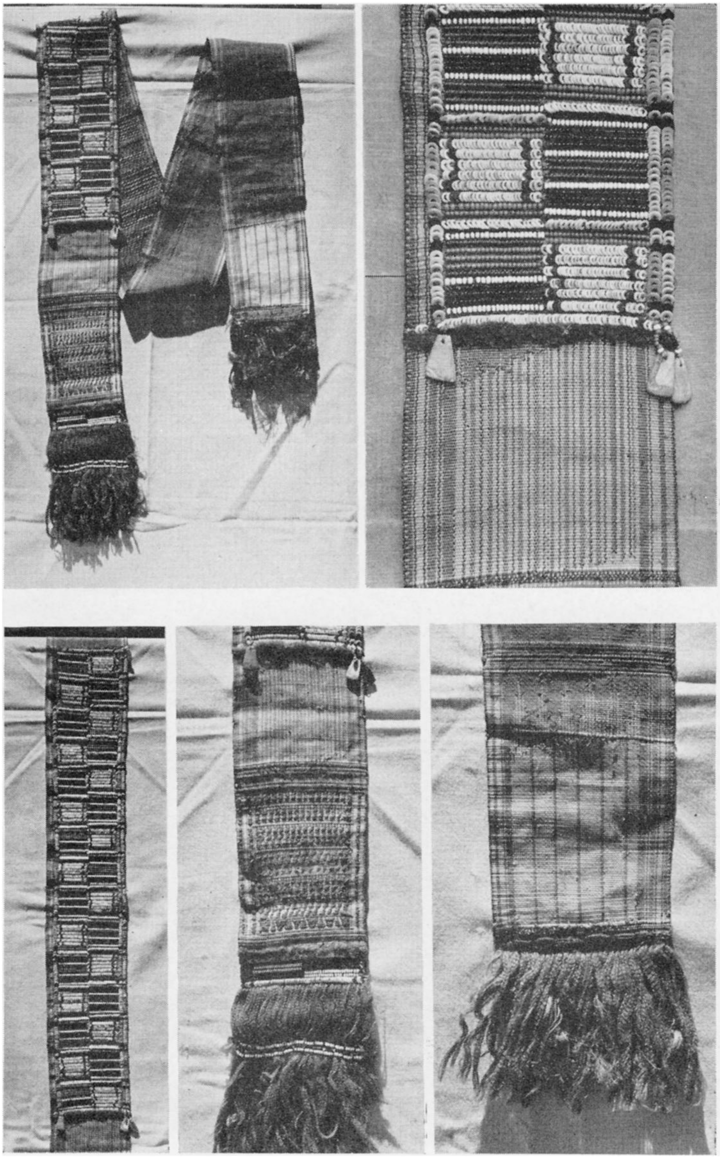
The other variant technique, in Section F of other belts—which are always closely striped in color—is that called pattern weave: occasional warps are floated regularly to create a surface design instead of being bound in by every weft shot. An example is specimen 11-185. In all cases the warp float patterns are uncomplicated, being little more than a single warp in width. The short floats appear regularly as glossy vertical "dash" lines on the otherwise closely woven web surface.

Class C: Bead Encrusted Belts.[27] The belt from Ponape is basically like Class B, described above, consisting of a ring warp, knotted-in warp patterns, brocaded section, and special-color fringe. (The additional red wool yarn fringe is but a super-interpretation of the standard fringe in Class B belts.) (See Plate 2.)

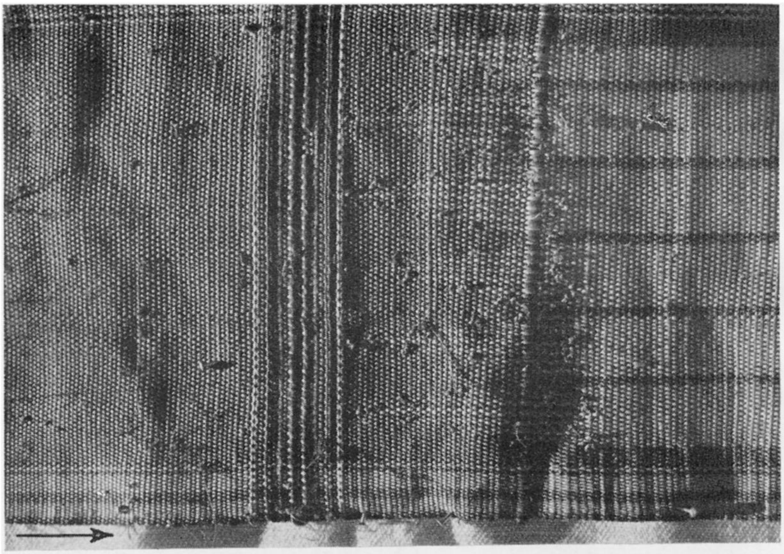
The individualistic feature of Class C is the ornamental patterning in beads which are in-woven as the work progresses, not applied after the web is finished. The extra wefts which carry the beads cause this portion of the belt to be put in the technical category of brocading. However, far more than simple insertion of a superstructural weft is involved, since not only are the bead ornaments to be carried on this weft and placed each in its exact position, but three more techniques are used to achieve the proper placement or "lay" of these items. Thus (1) the glass beads have one type of placement; (2) the shell beads overlap in shingled formation; and (3) vertical rows of shell beads stand on edge: the three variations occur side by side across horizontal units in the beaded section of the belt.

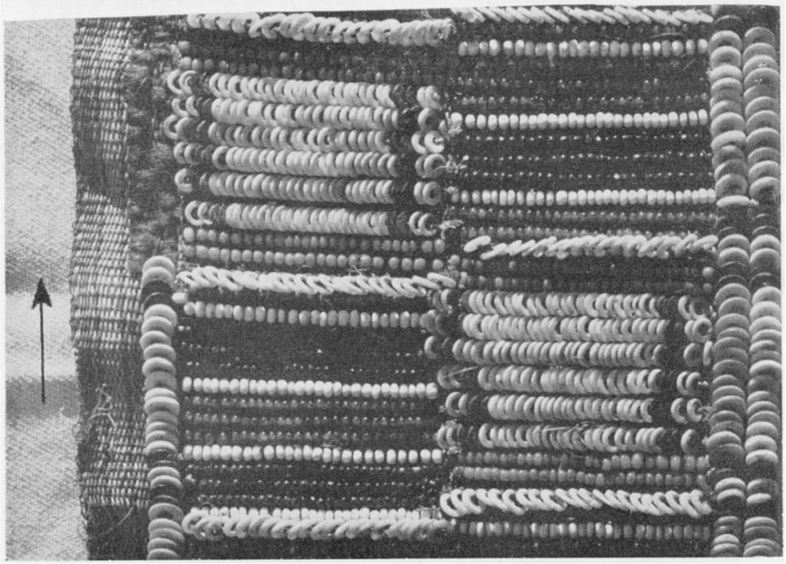
When this manipulative achievement is added to the already complex warp-

27 One example: owned by Saul Riesenberg (SR-Po). This is an heirloom belt known to have been made prior to 1870. Similar belts, some with more brocading and with more or less beading, are shown in Hambruch and Eilers, 1936, pp. 286-294, pl. 1 (1, 6).



BEAD ENCRUSTED BELT OF PONAPE, CLASS C





DETAILS OF CLASS C BELT

Top: Weft welts at end of Section E; knotted triangles in Section F.

Bottom: Bead imbrication (arrow indicates warp direction).

knotted patterning, it will be seen readily that the specialized textile art of Ponape is one of high virtuosity. There is little wonder that, having developed the skill necessary to produce such complex fabrics and arrived at a satisfactory formula for the handsome overlaid designs, there was little need aesthetically for the Ponapean weaver to experiment with other weaving methods.

On the island of Ponape brocading, whether beaded or not, has been elaborated as the major ornament on the fabric, overshadowing the knotted-in patterns by its boldness and complexity.[28]

Proportionate dimensions of Class C belts are longer and narrower than those of Classes A and B. The Ponapean belt (SR-Po) has a length (cut warp) of 70¼ inches with a width varying slightly between 4 and 4½ inches. The width is about one-seventeenth of the length.

Thread count of our specimen averages 57 warps to 29 wefts per square inch, clearly a warp-face ratio, but coarser than Kusaie Class B.

Warp and weft yarns are of banana fiber of like quality and size. Here, however, the size as compared to yarns in Class A and B belts is a heavier quality, being about equal to the coarsest yarn used in Class A. Tightness of weave seems constant in all belts handled, so is not a factor in the count.

Extraneous fibers in the Ponapean belt are a blue cotton and a yellow and a red wool, all used decoratively for brocading or fringing. (Hambruch and Eilers mention red, yellow, and blue wool as decorative yarns.)

The total composition of the belt adheres to the six section plan of Class B, but the sections differ markedly in interior scheme. The layout is shown in Figure 2, bottom: Section A1, A2, the warp fringes; Section B, brocade; Section C, warp stripes; Section D, bead encrustation; Section E, major plain area; Section F, warp knotted design.

The warping method is that described previously. Need for the grid warp-gauge is slight since the knotted-in designs are limited to stripes in Section C and graduated stripes in Section F. However, posts control the major change points between sections as in Class B construction. Only three colors—natural, rust, and black—are employed, which also lessens the task of intra-warp additions.

A major difference in overall planning for the Ponapean belt lies in a group of stripes which follow the selvage the full length of the warp. Beside their ornamental interest, they evidently serve the practical purpose of making a visible boundary for the added elements of brocade wefts and bead-carrying wefts. Only the red and blue wefts of brocade in Section B extend into the striped border, but not to the selvage.

28 See Hambruch and Eilers, 1936, *loc. cit.*

Because these outer stripes extend the full length of the textile, the standard rust-colored warps for the fringe (Section A) are set within this frame: as usual, the color change requires that they be knotted-in. In spite of the care taken to adhere to the traditional fringe color, these warp fringes are eventually totally obscured by the bright red fringe of wool set over them.

The knotted-in designs of Sections C and F may be described briefly. The stripes of Section C are black, natural, and rust (Plate 2, upper right) and are achieved by the usual means of a continuum if one color aligns in two or more adjacent design areas. Thus, natural stripes are a continuation from neighboring all-natural Section B; rust stripes, newly added for Section C travel beyond its boundary into the all-rust Sections D-E. This leaves black as the only stripe or warp color to be knotted-in for just the length of this three-color striped area.

Section F is more complex in design: a thinly striped rectangle of natural color with six triangular extensions on one end is set into a larger rectangle of solid rust which is bounded by the selvage stripes on each side and the usual cross welt at each end boundary (Plate 3, top). In the natural rectangle five thin stripes of rust and black divide it lengthwise into six broad bands which terminate in triangular forms made by continuing some of the natural warps into the rust background. The following knotted-in variables occur. Rust warps may (1) terminate at the tips of the triangular extensions, (2) continue to the base of the triangles between the extensions, or (3) continue—as in the thin stripes—through the natural rectangle to become warps in the rust fringe (Section A). The natural warps may be either the length of the rectangle they fill or may extend as lines to make the triangles: none extend beyond the boundaries of Section F. Black warp segments, used sparingly as accent, are knotted-in for just the length of the natural rectangle which they stripe.

The natural warp extensions comprising the triangles should number seven to a triangle: some discrepancy occurs both in their number and their lengths. The base line of the triangles should move straight across the web; this is indicated by a weft welting inserted, as usual, where knots abound in a horizontal line. How far this knot line missed position is clear in Plate 3, top, and the irregularity seems due to inaccurate measuring of the extenders. That is, the tips of the triangles are fairly well aligned, their bases are not.

Brocading with yarn has three major forms in this Ponapean belt: (1) the patterning of Section B, (2) the delimiting of section boundaries, and (3) the adding of red wool as pile and fringe. In the first case the brocading method is that used in Class B belts: blue cotton and red wool alternate pleasingly as bands of small simple geometric figures within the side boundaries of the selvage stripes.

Each band is separated by two weft shots of blue in an over-three, under-one shed which run to the same side limits. The brocading wefts of the patterned bands, however, float on the back of the web to emerge and cross the rust lines of the selvage stripes before returning for the next shot. These surface floats form narrow blocks of red and blue paralleling the patterned area (Plate 2, bottom center).

The divisional welts of brocade are expanded into a cluster of cross lines in the Ponapean belt. Where a section line coincides with a line of knots the introduced welt weft is of brown banana fiber. The additional decorative cross lines of brocade, all in an over-three, under-one shed, are of red wool, yellow wool, blue cotton, natural and brown banana fiber. Color preferences for these are: red used 17 times, blue 13, natural 7, yellow 6, and brown 2. These clusters of colored rows are a distinctive, finely-made detail of this belt.

The red wool used for pile and fringe is inserted under the warps as a superstructural yarn; i.e., the basic weft continues in the same shed. Closely packed loops of the wool—long or short as needed—have been drawn under a few warps at a time leaving the ends to hang out. The lines of pile at section divisions A2:B and C:D are roughly trimmed to about a quarter-inch depth. The resulting bright thick crest of fuzz contrasts sharply with the flat fine-textured fabric. Wool fringe ends hang in long loops covering the under fringe of rust fiber warps. Bead work embellishes the wool over-fringe in half A2.[29] Strictly speaking, these wool additions are not brocade, but the technique allies more with the brocading method used elsewhere in the belt than with any true pile technique which involves knots or twists.[30]

The bead encrustation which gives the handsome character to the Ponapean belt is a work of artistic skill. Alternate blocks of shell disc rings and of trade beads fill Section D, while rows of the shell discs parallel its boundaries along the selvage stripes (Plate 3, bottom). The shell provides three colors—a creamy white, a pale yellowish pink, and a smoky black: all are used with deliberate effect. The glass beads of a dark brownish red and strong deep yellow pick up the major hues of the rust and natural fibers of the fabric. Black and white beads produce a heavy accent, and a limited introduction of lambent blue beading brings piquancy to the total color scheme.

Not only have the bead colors been distributed in fullest effect; bead contour has been played up as well through manipulative technique (Plate 3, bottom). The glass beads are small, spherical, and lie almost embedded in the fabric as flat,

29 Hambruch and Eilers (1936, fig. 70) show one fringe with a similar cross-binder.

30 Such as the familiar Ghiordes or Senna rug piles.

strongly striped areas. The complementing areas are of white shell discs arranged as a shingled surface. Between each of the block areas there rises a crest-line of shell discs set on edge which accentuate the three-dimensional quality of the whole beaded section. The combination of color and texture is superlative: no more masterful use of the materials could have been made by the most sophisticated designer.

As to workmanship, the weaver's patience and skill have been aimed toward perfect production. The application of the superstructural ornament is basically a brocading technique, but to attain the three types of surface-contouring four methods of imbrication necessarily occur along the same shed-line on each ornamental row. These methods are shown in Figure 3e and display the arrangements more lucidly than a prolonged verbal analysis.

In brief, the methods are these. The rows of glass beads are carried on a sustaining weft which may be continued through several rows regardless of color change. This dark grayish weft passes under every fourth warp between which a bead is located. (At all times the basic rust weft of the fabric continues in its normal over-one, under-one shed.) (Figure 3, e1.)

The shell disc rings which are shingled are retained in position by three strands. One is the sustaining weft carrying the discs and running under every fourth warp. The other two, as an opposing pair, cross under the lower edge of a disc, then pass over the sustaining warp, and turn downward to cross under the next disc. The spiral lashing action of these taut binders forces the discs sideways into an overlapping position. (Figure 3, e2.)

In the vertical ridges, each shell disc retains its place by being raised on a lashing strand which passes through the ring and takes one or more turns on itself to form a short wrapped "stem." This strand then passes under a raised warp and under a sustaining weft which, like the others, lies below every fourth warp. The discs stand erect, overlapping diagonally. (Figure 3, e3.)

The long rows of shingled discs which parallel the beaded Section D are held there by lashing strands which travel along the warps. A pair of fiber yarns carries the shell rings and by an opposed spiraling progression move through the center of a disc and under a surface warp repeatedly. Here again, tension on the lashings forces the discs to flatten down over each other.[31] (Figure 3, e4.)

31 Throughout Section D the bead encrustation is so tightly applied that it is extremely difficult to analyse the foundation which it obscures. We are indebted to J. W. Baughman for checking and corroborating our findings.

CONCLUSION

From the evidence presented it seems clear that the spread of weaving into Oceania was from Indonesia into the Caroline Islands and thence into Melanesia. That this was not a simple process is equally evident, diffusion in various directions causing considerable complication. We may suppose that ring-warp weaving was introduced from Indonesia into the Western Carolines first, that it by-passed Palau and spread eastwards. The loom with cylindrical beams diffused to the end of the Caroline chain. Later, open-warp weaving was introduced on Yap, but did not pass beyond this northwesterly Caroline island. The board shaped beam spread independently and later into the Carolines, replacing the round beam in most islands, existing side by side with it in some of the eastern islands, changing to the form square in cross-section in some of the central islands. Meanwhile the older, cylindrical beam spread south, probably via Kapingamarangi, into Melanesia. The square beam of the central islands also diffused south, again via Kapingamarangi, so that both round and square beams are found in Melanesia today. The board-shaped beam failed to reach Melanesia except for the single occurrence at St. Matthias, which must represent a separate introduction.

The pair of laths for the lease occurs in the Carolines only in the eastern islands and some of the central islands; it seems to be the older form, co-existing with the later, single lease rod in those islands, and replaced entirely by it in the west. Since the paired-lath lease is the only form in most of Melanesia, it presumably spread south, possibly accompanying the round and square beams, before the single lease rod entered the Carolines from Indonesia. Again the path of diffusion leads via Kapingamarangi. The occurrence of the newer form at Takar-Saar and St. Matthias suggests a second, separate introduction of weaving to these areas.

Since the two-edged sword (batten) is in Micronesia almost confined to the eastern half of the Carolines, we may look to that area for the source of the trait in Melanesia, where it is the only form known. Details in resemblance once more point to Kapingamarangi as the intermediate source. The two-edged sword seems once to have extended through the Pacific weaving area, but has been replaced in the west by the later single-edged type, which today is almost exclusive in Indonesia. It has survived in the west only on Sonsorol.

The open-bodied bobbin, though sporadic in distribution, again leads us from the Central Carolines, via Nukuoro and Kapingamarangi, into Melanesia. Probably it is of local origin in the Central Carolines.

The warping bench leads from the Eastern Carolines, via Kapingamarangi, to St. Matthias: the associated measuring grid, invented in Ponape or Kusaie, did not diffuse with it. The occurrence of warping frames in Indonesia may indicate a former continuous distribution with subsequent loss in the intervening area where they are absent today. But since there is no trace of them on any island in the western and central groups, independent invention on Kusaie or Ponape is not improbable.

The knotting-in of designs of the Eastern Carolines apparently has a relationship with the very elementary method of Lukunor and Namoluk. Whether the simpler form represents that from which Kusaie and Ponape weaves have sprung, or whether it is a degeneration of the more elaborate technique of the latter islands cannot, of course, be definitely ascertained. The method and the geographic continuity, however, clearly indicate a genetic relationship.

Absence of warp-striping ties the Melanesian area to either the Southwestern Carolines or to the two central islands of Namonuito and Puluwat, with Kapingamarangi and Nukuoro furnishing a link in the latter case. The presence of striping at Takar-Saar and St. Matthias indicates a separate influence in these islands. Similarly, absence of pattern weaving reveals a relationship of Nukuoro and Kapingamarangi to Melanesia, and absence of brocading ties Kapingamarangi to all of Melanesia.

Narrow fabrics for men's use are characteristic of Kusaie and Ponape in the east, also in the Southwestern Carolines, while elsewhere in the Carolines woven fabrics for both sexes are wide. Men's breechclouts are narrow also on Nukuoro and in the Melanesian weaving area. The direction of diffusion would seem to lead from the Eastern Carolines to Melanesia via Nukuoro. (Kapingamarangi is not involved, since there the breechclouts were of barkcloth.) The southwestern islands are doubtless too remote geographically to affect the picture directly, which is also true in the case of stripeless weaving.

Masculine weaving appears to be independent in origin on Kapingamarangi and to have spread thence to Melanesia; the exceptions in Sikayana and St. Matthias suggest additional influences here from elsewhere in the Carolines.

The bond between Micronesian and Melanesian weaving is demonstrated in the following reconstruction of their affinities:

Cylindrical beams: Lukunor, Ponape, Kusaie; to Nukuoro and Kapingamarangi; to the Polynesian outliers in Melanesia; to Santa Cruz and Banks. Kapingamarangi to St. Matthias (and Takar-Saar?).

Square beams: Namonuito, Pulusuk, Truk, Lukunor; to Nukuoro and Kapingamarangi; to the Polynesian outliers.

Board beams: Carolines generally to St. Matthias.

Paired-lath lease rod: to Central and Eastern Carolines; to Kapingamarangi; to outliers; to Santa Cruz and Banks.

Single lease rod: Carolines generally (or Indonesia?) to Takar-Saar and St. Matthias.

Double-edged sword: Carolines east of Pulusuk-Puluwat; to Nukuoro; to Kapingamarangi; to Melanesia. *Double-edged sword with one point:* Lukunor and Kapingamarangi to Melanesia. *Keel-ridge:* Lukunor; to Nukuoro; to Kapingamarangi; to Santa Cruz and Banks.

Open-bodied bobbin: Pulusuk; to Nukuoro; to Kapingamarangi; to Sikayana; to Santa Cruz.

Warping bench: Ponape and Kusaie; to Kapingamarangi; to St. Matthias.

Warp-striping: Carolines generally (or Indonesia?) to Takar-Saar and St. Matthias; degenerate form at Sikayana.

Absence of warp-striping: Puluwat and Namonuito; Nukuoro; Kapingamarangi; Melanesia.

Absence of pattern weaving: Nukuoro; to Kapingamarangi; to Melanesia.

Absence of brocade: Namonuito, Pulusuk; Kapingamarangi; Melanesia.

Narrow men's garments: Kusaie and Ponape; to Nukuoro; to outliers; to Santa Cruz. Nukuoro to St. Matthias.

Wide sarongs: Kapingamarangi or elsewhere in Carolines; to outliers; also to St. Matthias.

Feminine weaving: Carolines generally to Sikayana and St. Matthias.

Masculine weaving: Kapingamarangi; to Polynesian outliers (except Sikayana); to Santa Cruz.

Kusaie and Ponape thus are involved, apparently, in the diffusion to Melanesia of cylindrical beams, use of paired laths for lease rods, double-edged sword, warping bench, and narrow men's cloths. In addition they possess, among other traits which did not spread to Melanesia, the knotting-in technique and, in Ponape, ornamentation with shell beads; the former occurs in much simpler form a Lukunor, Satawan, and Namoluk, the latter at Truk. Here the knotting-in technique may be interpreted either as incompletely diffused elements or as original forms from which the Ponape-Kusaie developments sprang. The Central Carolines, particularly Pulusuk and Lukunor, may likewise be involved in the diffusion to Melanesia of some of the above elements (cylindrical beams, paired lease rod, double-edged sword) as well as square beams, open-bodied bobbin, and the loss of warp striping. Separate diffusions which did not come via Kapingamarangi may account for the presence on St. Matthias of the single lease rod, warp-striping, and feminine weaving; and on Sikayana of a form of warp-striping and of feminine weaving. Of these traits, feminine weaving may have reached St. Matthias and Sikayana via Nukuoro without involving Kapingamarangi. Board beams reached St. Matthias, possibly, through Kapingamarangi, but in a separate diffusion that did not affect the rest of Melanesia. It is possible that many of these distributions represent cases of discontinuities caused by persistence in marginal areas with abandonment in intervening areas. Weaving in the Takar-Saar area of New Guinea seems to be of direct Indonesian origin instead of coming via the Carolines. Geography suggests this, as well as the presence of such Indonesian traits as stick-shaped bobbins (also present on St. Matthias) and the use of cotton instead of the prevalent banana or hibiscus fibers. Both of these are absent in the rest of Oceania. St. Matthias also is unique in using pandanus for loom weaving.

A consideration of weaving methods and materials leads us to an hypothesis concerning the development of the specialized textile art of the Eastern Carolines —Kusaie and Ponape.

The ring method of warping is general over the Indonesian-Micronesian-Melanesian weaving area. Likewise the manufacture of yarn by knotting the banana fibers together is common, often the only method, wherever plantain or other long-staple fibers are used. Warp-face weave seems to be the traditional structural technique: it is an elementary technique ubiquitous amongst primitive weavers. However, if color is to be entered, this must be done either in the warps, or with surface brocading, since the wefts are obscured by the warp elements. When using the ring warping method (a continuous spiral of yarn), a new colored warp can only be obtained by tying or knotting it in at the proper points. To a weaver already working with yarns built by knotting this should have been an easy step, and may have been made independently in some of the weaving islands now having striped fabrics. Development of stripe designing with the finesse of the Kusaie belts calls for imagination and skill: the planned effect must be carried out during the warping process and, once done, cannot be changed.

Another stage in warp designing, making use of the knotting-in method, is to enter colors which do not run the entire length of a single warp circuit. Simple effects of this sort appear in the fabrics of Lukunor, Satawan, and Namoluk, and presumably were once used by weavers of Kusaie and Ponape before they moved on to their extreme elaboration of this designing method.

On Kusaie and Ponape—not content with the complex broken blocks, stripes, and fringes, evolved from knotting in multitudinous short lengths of color—the weavers made use of the only other ways of obtaining ornament on a warp face web: floated warps (pattern weave) and brocading. Both these techniques are used tentatively on Kusaie without the mastery manifest in the knotted-in designs. Pattern weaving has a wider distribution in the Carolines, but on Ponape and Kusaie remains undeveloped in its design possibilities. The vigorous knotted designs of Kusaie and brocade motifs of Ponape may have held warp-float patterning in abeyance on these islands.

On Ponape alone the possibility of using a superstructural (brocading) yarn to carry bead ornament was envisaged. While brocading alone is more highly developed here than on Kusaie, it must be pointed out that the brocading yarn carrying the beads is not ornamental in that circumstance, but a functional element. The basic technique, however, is ideationally the same.

In sum, it is our belief that the elaborate elegantly designed fabrics of Kusaie and Ponape are the florescence of locally known techniques: they result from an internal sequential development. The possibilities for such development are inherent in the basic elements common to the Micronesian-Melanesian weaving area, namely, the knotted yarn, the ring warp, and the warp-face weave.

We are interested in putting forward this theory of local development because the superficial resemblance of Kusaie-Ponape knotted designs to ikat (resist-dyed) textiles has been the basis for two other theories of their origin. The first of these holds that knotted-in warp designing was once more general in the Indonesian-Micronesian contact area and that the Micronesian technique was the inspiration for ikat designing now prevalent over most of Indonesia, but where knotting-in is unknown. That is, the idea of dyeing a warp yarn length in two or more colors was substituted for tying in various colors.[32] The second theory is the reverse: that Caroline knotted designs resulted from an attempt to duplicate resist-dyed fabrics of Indonesian source. Both theories have been repeated by several writers.[33]

The first theory is, of course, concerned rather with the origin of ikat technique, not the knotted-in method of designing. There is no occurrence of knotted designs outside the Caroline Islands known to the authors. At least some survival of the method would be expectable had it ever been general in Indonesia. Moreover, that ikat should have originated in warp-knotting seems improbable in the

32 Linton, 1926, p. 53.

33 Nevermann, 1938, p. 117 (an inclusive reference). Christian likened Kusaie fabrics to ancient Japanese *basho-fu* cloth but did not specify any resemblance beyond the fiber material (Christian, 1899, pp. 394, 397).

light of the extreme antiquity of ikat in India as clearly shown in the Ajanta Cave paintings.[34]

That warp-knotted designs should have resulted from contact with ikat patterned fabrics seems implausible for reasons over and above those which logically indicate an internal development. Resist-dyeing techniques are unreported from Micronesia; the nearest source of ikat fabrics would be the Philippines or Celebes.[35] Dyers and weavers of such skill as the eastern Carolinians would immediately recognize any ikat fabric which came to their hands for what it was—composed of yarns sectionally dyed—and easily enough have devised a method of duplication. Besides, any hypothetical ikat fabric which might have reached Kusaie-Ponape would have been in but two or at best three colors. Kusaie belts employ five colors. Neither the design motifs nor total composition of the Kusaie-Ponapean belts bears any resemblance to the ikat fabrics of nearest possible Indonesian sources, e.g., Borneo, Celebes, Philippines.

Shell discs and the substituting or augmenting European beads are common enough sewn, strung, lashed, or glued to various types of objects including textiles, in the general Indonesian-Micronesian-Melanesian island area. But the Ponapean method of imbrication relates to their weaving method, brocade; the product seems wholly aboriginal in design and technique. Embellishment with either the glass beads or ravelled wool are contact indicators only and imply nothing more than an addition of new and interesting materials in a manner already established in native practice.

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34 Iklé, 1931, pp. 3, 5, 46, fn. 27.

35 Bühler's study of resist-dye techniques, their classification and distribution, clearly shows the absence of these methods in Micronesia. Resist-dyeing, which does occur in Melanesia, is not associated with loom-made fabrics (Bühler, 1946, pp. 322-327, 332-336).

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