

William Morris and Indigo Discharge Printing

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As a neophyte dyer in the 1970s, I was amused and intrigued by accounts of William Morris' encounters with the indigo vat in the 1870s. It was after I had become a more experienced dyer that I had the very special opportunity to study Morris' Merton Abbey Dyebook and thus to obtain first hand knowledge of his techniques and recipes.¹ Walter Crane tells of a friend calling on Morris at the Merton Abbey works, asking for him, and "hearing a strong cheery voice call out: 'I'm dyeing, I'm dyeing, I'm dyeing'"² Morris appeared, his hands stained blue from work with the vat. Earlier, Morris maintained an indigo vat and dye facility at Queen Square. He writes to Jenny, in 1877: "Well, my dear daughter, since I have been dyeing this morning, I must go and try to get my hands cleaner least they shouldn't let me into the theatre after all".³ When experimenting with the indigo vat at Leek, as Henderson tells us, Morris' "hands and arms up to the elbow remained permanently blue".⁴ "I trust I am taking in dyeing at every pore (otherwise than by the skin of my hands, which is certain)", Morris remarked to Georgiana Burne-Jones, in a letter from Leek, Staffordshire,⁵ where, at intervals in 1875, 1876, 1877, 1878, Morris would stay and collaborate in experimenting and developing dyes and printing with Thomas Wardle, an expert on dyeing and silk cultivation, at Wardle's dyeing firm. The desire to master the indigo vat on Morris' part stemmed not only from the desire for high-quality light and wash-fast colour but also from a particular colour sensibility. Morris began designing printed textiles in 1873 and was particularly unhappy with the Prussian blue printing in 'Tulip and Willow' done by Thomas Clarkson of Bannister Hall.⁶ Thomas Wardle, speaking on the art of textile printing, said of Morris that "the slightest departure from colour harmony jarred upon his mind and eye like an unresolved discord on his ear. The pains he took to get his colouring right were immense as were his powers of resolve and work".⁷

Morris' colour aesthetic had a great part of its origin in his appreciation of medieval and, later, Persian art, and embraced the primaries, particularly red and blue. W. R. Lethaby in speaking of Morris' mastery of colour as being shown in his choice of single colours, red, green, yellow, blue, says Morris "looked on these colours when *pure* as in themselves beautiful natural products, the individuality and flavour of which would be destroyed by too much mixing".⁸ This colour aesthetic was part of Morris' general search for strength of expression, and quite counter to the colour sensibility that incorporated hues lacking purity and luminance, exacerbated by the invention of aniline dyes, the first being mauveine in 1856 by William Henry Perkin. In 1888, Morris stated:

... no textile ornament has suffered so much as cloth printing from those above-mentioned commercial inventions [printing by block or cylinder-machine]. A hundred years ago the processes for printing on cloth differed little from those used

by the Indians and Persians; and even up to within forty years ago they produced colours that were in themselves good enough, however inartistically they might be used. Then came one of the most wonderful and most useless of the inventions of modern Chemistry, that of the dyes made from coal-tar, producing a series of hideous colours, crude, livid – and cheap – which every person of taste loathes ...⁹

In this passage on the ornamentation of cloth by printing, two of Morris' essential concerns appear: the technical process of printing and colour quality. In referring to the commercialization of fabric-printing, Morris evidently had in mind the predominance of cylinder printing beginning at the end of the eighteenth century, and the concomitant decline of handblock printing. This decline was further accelerated by the invention of the Perrotine in 1835; this machine used woodblocks attempting to imitate the appearance of hand printing.¹⁰ As we shall see, Morris chose as the means for producing his textile designs, handblocks (the use of which had almost vanished in Great Britain by 1840¹¹) for mordant printing and discharge printing. (A mordant is a metallic compound used in dyeing that combines with the dye to fix the colouring matter; discharge is the removal of colour by chemical means.) Below, we will discuss these processes in some detail.

The second of Morris' essential concerns, colour quality, is coupled with an aesthetic that specified a particular colour palette, based predominantly on red, blue, yellow, and brown. W.R. Lethaby characterizes Morris' colours as "bright ... with pure patches of each beside each in various relations of quantity and intensity."¹² In facing the problem of creating colour quality by controlling the dyeing process and restoring art to dyeing, Morris advocated returning to ancient practices. He did much historical research and developed an applied knowledge of dye chemistry. This is evidenced in his essay 'Of Dyeing as an Art'.¹³ When he wanted a certain colour effect he would use that which gave it best without compromise in quality for the particular circumstance. Although, as we have seen, Morris spoke harshly about the "hideous colours" produced by synthetic aniline dyes, there is reason to believe that he was not averse to using synthetic dyes when he found the colours produced pleasing and fast. A case in point is the range of red hues from madder root. The chromophore (colourant) compound in the root of madder plants (*rubia tinctorum* and *rubia peregrina*), called alizarin, was isolated in 1826 and synthesized in 1868. Alizarin for dyeing had been expensive and only available in relatively dilute concentrations before the synthesized substance became readily available. The concentration of colourant in the root is very low, only 2 to 4 per cent. In addition, because of the greater concentration of the colourant, brighter, clearer colour quality was more easily obtainable.

In a letter to Wardle in 1875, Morris wrote, "I don't think you *can* get a bad colour with the aluminous mordant on the *unbleached* cloth, so long as the cloths are not starved of the madder".¹⁴ In subsequent correspondence, at this time, Morris suggests using garancine or alizarin.¹⁵ Garancine was a commercial product that concentrated alizarin from the madder root, yielding a concentration of 6 to 12 per cent. On the other hand, synthetic alizarin was available in a paste form with a 20 per cent concentration of the colourant.¹⁶ The word 'alizarin' itself came to be used ambiguously to refer either to the dyestuff derived from the madder root or to the synthesized substance. In discussing with Wardle dye samples for woollen velvet,

Morris says about “artificial alizarin”: it is a pleasant colour...¹⁷ Of course, the synthesized organic alizarin molecule derived from coal-tar is chemically identical in its molecular structure to the molecule in the root, so that no chemical analysis of cloth samples could be expected to determine which was used. The transition from the use of madder to the synthesized alizarin was accomplished within twenty years of its invention. By 1890, alizarin derived from coal-tar as a dye with identical colour properties, greater purity and ease of use and lower cost than alizarin from madder root had, for the most part, replaced dye products from the madder plant.¹⁸ “Madder is now alizarin”, says Australian dyer Max Simmons.¹⁹ However, we cannot say with certainty when “alizarin” is specified in the Merton Abbey Dyebook, which is meant: a concentrate from the root or the synthesized dye.²⁰

The 1870s and 1880s, when Morris was learning and practicing dyeing and printing, were years of transition for this particular dyestuff. The Dyebook is written in various hands, not identified, and was in use over many years, even subsequent to Morris’ direct supervision. To a practicing dyer, further considerations suggest themselves. Morris was one to go to the essence of questions rather than be distracted by form.²¹ Although Morris excoriated aniline dyes, it was the combination of commercialization of technical process and colour quality that they facilitated that drew his wrath. In characterizing them as “most useless”, as we have seen, he speaks of the “hideous colours”; he also states that they do “great service to capitalists in their hunt after profits”.²² However, with alizarin, the colour quality is identical, whether the synthesized or the “natural” substance is used. In the realization of design on fabric, mordant printing was an important part of Morris’ repertoire. The thickened mordant is printed in a specified design in designated areas and dried. The dyestuff gives the desired colour by interacting with the mordant, either via immersion in a dyebath or by steaming. Alizarin is compatible with direct mordant printing. The cloth can be printed with different mordants at the same time and different colours will then develop from the same dye application. Synthesized alizarin is particularly appropriate for this process because of its concentration and freedom from grit. In my opinion, Morris would have had an appreciation of the foregoing, realizing that use of the synthesized dyestuff would not at all compromise the colour quality of the pure red he desired. Also, the synthesized alizarin’s purity and concentration would have meant a reliability, and hence predictable cost, important in workshop production. Pages 3 to 11 of the Dyebook record¹¹ patterns printed in red and white. These are the first recipes in the Book and specify “madder (alizarin)”. The Patent Office Design Register dates these patterns from 1882 to 1885, ‘Bird and Anemone’ and ‘Brother Rabbit’ being the first two.²³ In multicolour prints such as ‘Wey’, ‘Loddon’, ‘Wandle’, ‘Medway’, ‘Red Cray’, ‘Evenlode’, and ‘Strawberry Thief’ (1883), the overdyes on the indigo discharge are alizarin (sometimes RA alizarin is the dye named) for the red, and for the yellow, weld (a vegetal dye). Other yellows were from fustic, a dye wood, and from quercitron, obtained from oak bark, or its distillate “flavine”. Brown was mostly from the roots of the walnut tree, or catechu, a plant juice. [MAD 37, 38, 39, 40, 41, 42, 49] Although when green was desired in these prints, it was produced as a yellow overdye on various shades of vat-dyed indigo, the green in ‘Trent’ (1888) and ‘Daffodil’ (1891) is ceruleine. It is particularly noteworthy that the synthetic dye ceruleine was specified for these designs for printing on linen and chintz respectively. [MAD 51, 55]²⁴

Despite the foregoing, it is important to note two principal points that Morris had made in excoriating the fugitive and characterless aniline dyes in use in the early years after 1858. One point was a preference for the strong rich clear palette of primary and secondary colours of traditional vegetal dyes as opposed to the mixed and muddy aniline hues. Morris characterizes the pre-aniline colours, mordanted with alum, as beautiful and bright, and having the possibility of being “modified and toned without dirtying.”²⁵ Presumably for the reason of colour quality, Morris comments on red that “Al-kermes or coccus (an insect dye) ... produces with an ordinary aluminous mordant a central red, true vermilion with a good dose of acid, a full scarlet ... and was used until about the year 1656, when a Dutch chemist discovered the secret of getting a scarlet from cochineal, (also an insect dye) using tin and so produced a cheaper, brighter, uglier scarlet”.²⁶ Morris disliked Prussian blue dyeing (a brilliant blue mineral dye discovered about 1810), which has “cheapened and worsened black-dyeing, in so far as it has taken the place of the indigo vat as a basis”.²⁷ The second point is that Morris strongly felt the fugitive character of the early aniline dyes and the resultant colour to be unacceptable. Important for Morris, vegetal dyes faded to shades he approved of:

Like all dyes, they are not eternal; the sun in lighting them and beautifying them consumes them; yet gradually, and for the most part kindly ... These colours in fading still remain beautiful, and never, even after long wear, pass into nothingness, through that stage of livid ugliness which distinguishes the commercial dyes as nuisances, even more than their short and by no means merry life.

I may also note that no textiles dyed blue or green, otherwise than by indigo, keep an agreeable colour by candle-light: many quite bright greens turning into sheer drab. A fashionable blue which simulates indigo turns into a slaty purple by candle-light; and Prussian blues are also much damaged by it. I except from this condemnation a commercial green known as gas-green, which is as abominable as its name, both by daylight and gaslight, and indeed one would almost expect it to make unlighted midnight hideous.²⁸

A fundamental tenet in Morris’ approach was a thorough understanding of technique, which required not only knowledge of what had been done but also personal practice. For the establishment of the desired hues, a knowledge of the art and craft of dyeing was prerequisite. To control the process of dyeing was indispensable because, in Morris’ words, “upon it is founded all the ornamental character of textile fabrics.”²⁹ For these reasons, Morris wrote: “Henceforward there is an absolute divorce between the *commercial process* and the *art* of dyeing. Anyone wanting to produce dyed textiles with any artistic quality in them must entirely forgo the modern and commercial methods in favour of those which are at least as old as Pliny, who speaks of them as being old in his time.”³⁰ He asserted that: “The art of dyeing ... is a difficult one, needing for its practice a good craftsman, with plenty of experience. Matching a colour by means of it is an agreeable but somewhat anxious game to play.”³¹

The history of Morris’ experience with dyes and dyeing is covered in detail by Linda Parry in *William Morris Textiles*, by Oliver Fairclough and Emmeline Leary in *Textiles by William Morris and Morris and Co. 1861-1940*, in an essay ‘Red and Blue’ by Deryn O’Connor in *William Morris and Kelmscott* and in Peter Roberts’ thesis ‘Morris and the Art of Dyeing, all of which are excellent sources.³² Morris,

unsatisfied with the printing of his designs by another firm, worked with great determination and verve with Thomas Wardle, a prominent silk dyer with a dyehouse in Leek, Staffordshire. Wardle printed yardage for Morris and continued to do so even after Morris had his own facility. They worked together intensively for a period of about three years, having an experimental dyehouse as an adjunct to Wardle's business.³³ For about two years, there were many visits to Leek, beginning in the summer of 1875.³⁴ Morris did hands-on work – we've already mentioned the colour of his hands. In describing the work to Aglaia Coronio in 1876, Morris says: "I am working in Mr. Wardle's dyehouse in sabots and blouse pretty much all day long ... There were four dyers and Mr. Wardle at work, and myself as dyers' mate: the men were encouraged with beer and to it they went."³⁵ A year later, in a letter to Georgiana Burne-Jones, Morris writes: "I daresay you will notice how bad my writing is; my hand is so shaky with doing journeyman's work the last few days." Morris' experiences with indigo dyeing were not unmixed. The letter continues:

... all will be ready for dyeing to-morrow in it [the indigo vat]: though by the way, if you are a dyer, you must call it her ... I have been dyeing in her all the afternoon, and my hands are a woeful spectacle in consequence: she appears to be all that could be wished, but I must say I should like not to look such a beast, and not to feel as if I wanted pegs to keep my fingers one from the other. I lost my temper in the dyehouse for the first time this afternoon: they had been very trying: but I wish I hadn't been such a fool; perhaps they will turn me out to-morrow morning, or put me in the blue-vat.³⁶

Morris and Wardle both were keen experimenters and researchers. There was even a visit to a woad dyer in Nottingham.³⁷ Sources that Morris is known to have owned and brought to Wardle's attention ranged from herbals to books on dyes and dyeing, including works by Thompson, Koechlin, Bancroft, Chevreul, and Persoz, to mention only a few. Morris' knowledge of dyes and dyeing went from Pliny to recent discoveries of his time.³⁸

Morris experienced frustration with dyeing and printing done by Wardle, particularly in the area of indigo printing. At Morris's request, Wardle tried one technique of printing indigo called 'pencil blue'. This technique involves printing indigo, usually using a brush, pencil or twig, with arsenic trisulphide (orpiment) to retard oxidation.³⁹ The unevenness of the final colour was a source of dissatisfaction and Morris desired to find a way to get the results he wanted by dip dyeing.⁴⁰ Although preoccupied with ideas for indigo printing for several years, the idea for indigo discharge printing (in which the entire cloth is dyed indigo after which the design is printed using a removal agent) was finally formulated in Morris' mind in 1881 as a result of reading Persoz' *L'Impression des Tissus* (Paris, 1846). In the year of the purchase of Merton Abbey, 1881, Morris notes in his diary on December 13: "reading and noting Persoz on blue-dipping".⁴¹ Morris was influenced by the look of old Indian chintz and had in mind the colours of Persian ornament which "had conquered everything of cotton printing in India".⁴² Some notion of what Morris would have found in his sources is provided in a relatively recent treatise on Indian cotton dyeing.⁴³ Traditionally a very complicated technique of mordant printing and indigo vat dyeing using resists had been employed in order to accommodate dyes whose processes were incompatible. As already explained, mordant printing is a technique that begins by

printing a design in the thickened metallic compound. After the print is dried, the printed mordanted area alone will capture and bind the colour when the cloth is immersed in a vat containing the colourant. What is so impressive about Morris' accomplishment is his success in finding a way around these complicated older techniques requiring a resist, by using indigo discharge printing followed if desired by mordant printing for further colours.

Morris by moving his works to Merton Abbey in 1881 provided himself with space to realize his dyeing ideas. Three designs, 'Brother Rabbit', 'Bird and Anemone' and 'Rose and Thistle', registered in 1882, were printed by indigo discharge solely, resulting in white and shades of blue. Another three in indigo discharge alone, 'Borage', 'Eyebright' and 'Wey', were registered in 1883; 'Lea' not until 1885. Up to 1885, Morris and Co. registered seventeen designs incorporating indigo discharge.⁴⁴ Indigo discharge alone results in a cloth with a design in blue and white. Designs for which more colours were desired were realized by successive mordant printings. Morris used, as did Wardle, carved pearwood hand blocks for his printing. In fact the procedure of dip dyeing and printed discharge that Morris developed was a unique and ingenious combination of historical and technical elements consisting of the ancient lore of indigo vat dyeing, contemporary discharge chemistry, and handblock printing, a craft that had largely been abandoned in England.

What type of indigo vat did Morris use? There is neither a definitive nor a single answer in the materials I have examined. Certainly Wardle and Morris experimented at Leek; Morris and his dyer, Goodacre, experimented at Queen Square. Wardle and Morris experimented with a hydrosulphite vat in 1875, and Morris tried all three at his London workshop.⁴⁵ The hydrosulphite vat is mentioned in 1876 as is the fermentation vat (*cuve d'Inde*).⁴⁶ The lime vat is also used; Morris discusses it and his experimentation for silk dyeing in a letter to Wardle in 1877.⁴⁷ Unfortunately, the Dyebook, kept at Merton Abbey from about 1882, is not specific on this particular point. Its recipes will be discussed in detail later, but it appears that by 1881, when production had begun at Merton Abbey, there was no need to write down the indigo vat specifics. Synthetic indigo did not appear until 1897, discovered and marketed by Badische Anilin Soda Fabrik. Therefore, the indigo was natural, probably Indian, since this was chiefly the quality indigo sold on the world market at that time.

The principal vat was very likely a zinc-lime vat. This type of vat, discovered in 1845, was the most important vat for cotton dyeing and was used by Wardle at Leek.⁴⁸ The Morris-Wardle correspondence for three years gives a fascinating glimpse into working methods, as Morris writes of his experiments, the results, and his observations. However, the Merton Abbey Dyebook doesn't mention a vat recipe. I believe that Morris would have used the zinc-lime vat not only because of its suitability, but also because sodium hydrosulphite as purchasable product (rather than a by-product of the chemical reaction in the vat) didn't exist until 1897. The Dyebook does list sodium bisulphite on the shelf inventory; [MAD opening page] so perhaps at some time they used a sodium bisulphite-zinc-lime vat in which sodium hydrosulphite is a by-product. Copperas (ferrous sulphate) was also on the shelf, making that type of vat a possibility. Since this type of vat was no longer in general use, it is not likely. Because the zinc-lime vat was standard practice and quite efficient and reliable, Morris probably kept it for his blue dipping on cotton and perhaps kept a fermentation vat for silk. The vat was of good

size – Morris mentions 200 gallons as just about right;⁴⁹ there were four deep vats for indigo cotton dyeing.⁵⁰

The first step in this system of printing is to dye the cloth, using a total immersion dipping method, to the darkest shade of indigo desired.⁵¹ There was a standardization of depth of hue set up at the dyeworks (probably experimentally) – the darkest shade was called No. 31, somewhat lighter shades are Nos. 17, 10, 6. The second step on the night before printing was to pass the goods through a bichrome mixture, to dry by morning, avoiding exposure to light (premature exposure would form the chromic acid that works with further acids to discharge). The bichrome recipe used is:

1 gallon water
1½ lbs acetate of chrome
6 oz caustic soda [MAD, 27]

Bichroming is necessary to aid the discharge.⁵² Next the discharge paste is applied by wood block. Carved wood block was Morris's preferred printing technique following that of India chintz, Morris' model of beautiful printed cloth. The method of block printing is quite suitable because "more play of delicate and pretty colour is possible, and more variety of colour also; and ... much more use can be made of hatching and dotting."⁵³ A hardwood, pear, because of its durability was used and produced for Morris by specialists in block cutting, Alfred and James Barrett.⁵⁴ The block has a carved raised portion of the design, positive or negative, which holds the thickened paste and prints it precisely. The discharge paste contains the chemical in thickened and printable form, required to remove the indigo from desired places, leaving, depending on the strength of the paste, white or values of blue. Then, further mordant printing can occur: for example, yellow on white; or overprinting, e.g. yellow on light blue would yield a green.

The Dyebook specifies three thickeners: dark British gum, light British gum (both dextrine) and gum Senegal (expensive). The standard thickening is:

1 gallon water
4 lbs light British gum
2 lbs gum Senegal
4 lbs pipe clay (kaolin)
Bring to boil in one half hour, boil for 2 minutes. Make beforehand to have cold for use. [MAD, 24]

The discharging agents added to this paste varied according to amount of colour removal desired. A maximum discharge (as in 'Brother Rabbit') was:

1 quart of thickener
Add warm; 2¾ oz oxalic acid dissolved in ¼ pt of water
Add cold: ¼ oz sulphuric acid in 2 oz water [MAD, 29]

One half discharge recipe reduces the amount of oxalic acid to 1 oz 10 drams and omits the sulphuric acid. [MAD, 33] Explicitly, the cloth should be cleared as soon as possible after printing with hot (160°F) water, with 1½ pints of caustic soda per piece being added to the clearing water. [MAD, 27]

After the clearing, rinse, sour (the sour is made with ½ pt of sulphuric acid for each piece). [MAD, 27] Wash well in soapy water and rinse.

In the further printing of other designs, mordants, each having a different concentration of alkali depending on hue and saturation desired, were printed. The greater the concentration the deeper and darker the hue. First, the mordants for red (madder or alizarin) and its overdyes; then for yellow (weld) and its overdyes are printed and dried. In one cloth, there was a red print surrounded by pale red – achieved by printing with alum mordants of different strengths.⁵⁵ Then the cloth with its dried mordant print is dyed in a vat of the appropriate colourant, alizarin, etc. There are also steaming techniques where the colourant is added to the mordant. After a final soaping and rinse, in good weather the printed cloth was laid out face up in the meadows to dry and bleach the whites further.⁵⁶

The process for indigo discharge printing we have described here is lengthy. William Morris was not an antiquarian bent on using the older great natural dyes; he revived them in the context of the chemistry of dyeing current in his time. Morris desired to produce cloth with the palette he defined and chose an ingenious method to do this, thereby leaving us with a unique heritage of beautiful cloth. In his words: “No; there is nothing for it but the trouble and the simplicity of the earlier craft, if you are to have any beauty in cloth printing at all. And if not, why should we trouble to have a pattern of any sort on our cotton cloths? I for one am dead against it, unless the pattern is really beautiful; it is so very worthless if it is not.”⁵⁷

NOTES

- ¹ I would like to take this opportunity to thank Sanford and Helen Berger for the generosity with which they made their collection, ‘The Sanford and Helen Berger Collection’, which includes the Merton Abbey Dyebook, available for study. The Dyebook measures 13½" by 9½" by 4". It has paper boards with leather binding, leather edges, and Turkish style marbled end papers. The pages are lined and numbered. The handwriting has not been identified. There are 111 written pages. The first two pages are a list of chemicals; the remainder contain dyeing recipes and procedures for each specific design, with samples of cloth attached up to page 74. Morris established his own print and dyeworks at Merton Abbey in June 1881. Quotations from the Dyebook are followed by bracketted references in the form of [M.A.D. p.].
- ² Walter Crane, *William Morris to Whistler*, G. Bell, London, 1911, p.24.
- ³ Norman Kelvin, editor, *The Collected Letters of William Morris*. Vol. I, Princeton University Press, New Jersey, 1984, p. 418. Letter 464. To Jenny Morris from Queen Square, 7 Dec. 1877.
- ⁴ Philip Henderson, *William Morris, His Life, Work and Friends*, McGraw Hill, New York, 1967, p.159.
- ⁵ *Collected Letters*, I, p.292. Letter 317. To Georgiana Burne-Jones from Leek, 26 March 1876.
- ⁶ Henderson, p.157.
- ⁷ As quoted in Peter Roberts, 1978 Thesis, ‘Morris and the Art of Dyeing’, at William Morris Gallery, Walthamstow, p.11.
- ⁸ William R. Lethaby. ‘Morris as Workmaster’. Lecture, Birmingham School of Art. Hogg, London, 1901, p.21.

- ⁹ Morris, 'Textiles', in *Arts and Crafts Essays*. By Members of the Arts and Crafts Exhibition Society, Rivington, Percival, & Co.; London, 1893, p.33. The Morris essays 'Textiles' and 'Of Dyeing as an Art' are from the catalogues of the Arts and Crafts Exhibitions of 1888 and 1889 respectively.
- ¹⁰ Stuart Robinson, *A History of Printed Textiles*, M.I.T. Press, Cambridge, Massachusetts, 1969, p.47.
- ¹¹ *Ibid.* p.27.
- ¹² Lethaby, pp.22-23. Lethaby quotes Morris as warning against too much iridescence: "It is apt to look like decomposition".
- ¹³ Morris, 'Of Dyeing as an Art', in *Arts and Crafts Essays*, pp.196-211.
- ¹⁴ *Collected Letters*, I, p.278. Letter 301: To Thomas Wardle from Queen Square, 16 Nov. 1875.
- ¹⁵ *Collected Letters*. I, p.280. Letter 303: To Thomas Wardle from Queen Square, 23 Nov. 1875; p.283. Letter 305: To Thomas Wardle from Queen Square, 24 Dec. 1875.
- ¹⁶ J.N. Liles, *The Art and Craft of Natural Dyeing*. The University of Tennessee Press, Knoxville Press, 1990, p.104. Max Simmons. *Dyes and Dyeing*, Van Nostrand Reinhold, Australia, Melbourne, 1978, p.60.
- ¹⁷ *Collected Letters*, I, p.269: Letter 290. To Thomas Wardle from Queen Square, 10 Sept. 1875.
- ¹⁸ Judith Lopez and Jane Farrell-Beck. 'What Colored the Transition from Madder to Alizarine?' *Clothing and Textiles Research Journal*. Vol. 10, No. 3, Spring 1992, p.36.
- ¹⁹ Simmons, p.60.
- ²⁰ I am indebted to Dr. Martin Bide, Department of Textiles, Fashion Merchandising and Design, University of Rhode Island. Dr. Bide, a specialist in textile dyeing and colour measurement, discussed these points with me.
- ²¹ In the opinion of W.R. Lethaby, *Philip Webb and his Work*, 1935, Ch. V, Morris and Webb as architects did not imitate superficial features of Gothic style but were concerned with the manner of work in the Middle Ages, with substance and structure in the handling of materials by the medieval builder. Moreover, Fiona MacCarthy in *William Morris: A Life for Our Times*, Faber & Faber, London, 1994, p.351, makes the observation that "Morris had no practical objections to the use of machinery *per se* so long as machines produced the quality he needed". From the foregoing one could say that it was not the coal-tar dyes themselves but the colours that most of them gave at that stage of their development and their inartistic commercial application that involved Morris' contempt.
- ²² Morris, 'Textiles' in *Arts and Crafts Essays*, p.32; 'Of Dyeing as an Art' in *Arts and Crafts Essays*, p.197.
- ²³ *Morris & Co. Collection of Sanford & Helen Berger*. Exhibition Catalogue, Stanford Art Gallery, Stanford University, March-May 1975, p.39.
- ²⁴ 'Green Birds & Anemone', p.47, and 'Green Florence', p.48, also use ceruleine for the green. ["Ceruleine", spelled "coerulein", appears as CI Mordant green 22 in the *Colour Index*, vol. 3, p.3141; vol. 4, p.4430. *Colour Index*, The Society of Dyers and Colourists & the American Association of Textile Chemists and Colourists, Yorkshire, 1971. 7 vols.]
- ²⁵ Morris, 'Of Dyeing as an Art' in *Arts and Crafts Essays*, p.209.

- ²⁶ Morris, 'Textile Fabrics'. A Lecture delivered at the International Health Exhibition, July 1884. *Collected Works of William Morris*. Vol. XXII. Longmans, Green & Co, London, 1914. p.292. Morris recognizes 1630, which is generally accepted, as the date of discovery of the use of cochineal with a tin mordant. (See p.256 in the essay, 'The Lesser Arts of Life' in *Collected Works*, Vol. XXII cited above). This discovery was made accidentally by the Dutch inventor, Cornelius Drebbel, while working on developing the thermometer. Sibertus Kuffler, a physician, had married Drebbel's daughter to obtain Drebbel's secrets, especially that of the scarlet dye. Kuffler gained access to Drebbel's dyeworks in London, opened a dyeworks in Holland, and returned to London in 1656, principally managing the dyeworks at Bow. The red produced there was called 'Bow' red. See H. G. Smith. 'Cornelius Drebbel and English Scarlet Dyeing', *Ciba Review*, Basel, Switzerland, Vol. 1, No. 7, March 1938, pp.231-233.
- ²⁷ Morris. 'Of Dyeing as an Art' in *Arts and Crafts Essays*, p.197. Prussian blue is used for producing a deep blue on silk, cotton and wool. This process of direct dyeing combining iron (ferrous) salts and potassium ferrocyanide (yellow prussiate of potash) was discovered in 1749, by Pierre J. Macquer. Known also as Napoleon's, Berlin, Turnbull's, Paris, Raymond's and Chinese blue, it was used extensively during the nineteenth century. See Franco Brunello. *The Art of Dyeing in the History of Mankind*. Neri Pozza Editore: Vicenza, 1973. p.231; J.N. Liles, *op. cit.* p.48. Morris disliked Prussian blue and expressed the hope to Wardle that with the mastery of the indigo vat "Prussian blues and greens will be things of the past with us or nearly so". See *The Collected Letters*. I, p.278. Letter 301, to Thomas Wardle from Queen Square, 16 Nov.1875. In this same letter, Morris encloses a "rag from the bed which heard my first squeak: my mother says it is about 6 years older than myself: I suppose it to be all indigo & madder except the yellow: the indigo is very nice and bright; whether it is dip-blue or china I don't know but it has certainly been blocked in some way ...". Later, Morris says that "the indigo on my natal print is *certainly* blocked in ..." See *Collected Letters*, I, p.279. Letter 303, to Thomas Wardle from Queen Square, 23 Nov. 1875. Because indigo is an insoluble dye that must be reduced to be put into solution with the colour developing rapidly on exposure to oxidation, to print directly with it requires special processes to retard the oxidation. One of these called 'pencil blue' or 'brush blue' having orpiment (an arsenic compound) as the indigo retardant, used willow twigs, a pencil or brush to apply the dye. Another printing method for indigo called 'China blue (English blue or bleu de faience)' didn't involve applying reduced and dissolved indigo with a retardant. Instead, the finely ground indigo mixed with copper sulphate and a thickener was printed in the desired design, dried, then immersed in a reducing solution so that the colour could reoxidize in place. See Liles, pp.91-95. See also Florence H. Pettit, *America's Indigo Blues: Resist-printed and Dyed Textiles of the Eighteenth Century*, Hastings House, New York, 1974. Glossary, p.233.
- ²⁸ Morris, 'Of Dyeing as an Art' in *Arts and Crafts Essays*, pp.210-11.
- ²⁹ Quoted in Aymer Vallance, *William Morris*. G. Bell and Sons, London, 1897. (Reprinted Studio Editions, London, 1986), p.96.
- ³⁰ William Morris, 'Of Dyeing as an Art'. *Arts and Crafts Essays*, p.198.
- ³¹ *Ibid.* p.209.