THE NEW DYER

with Colorcue hue analysis aide

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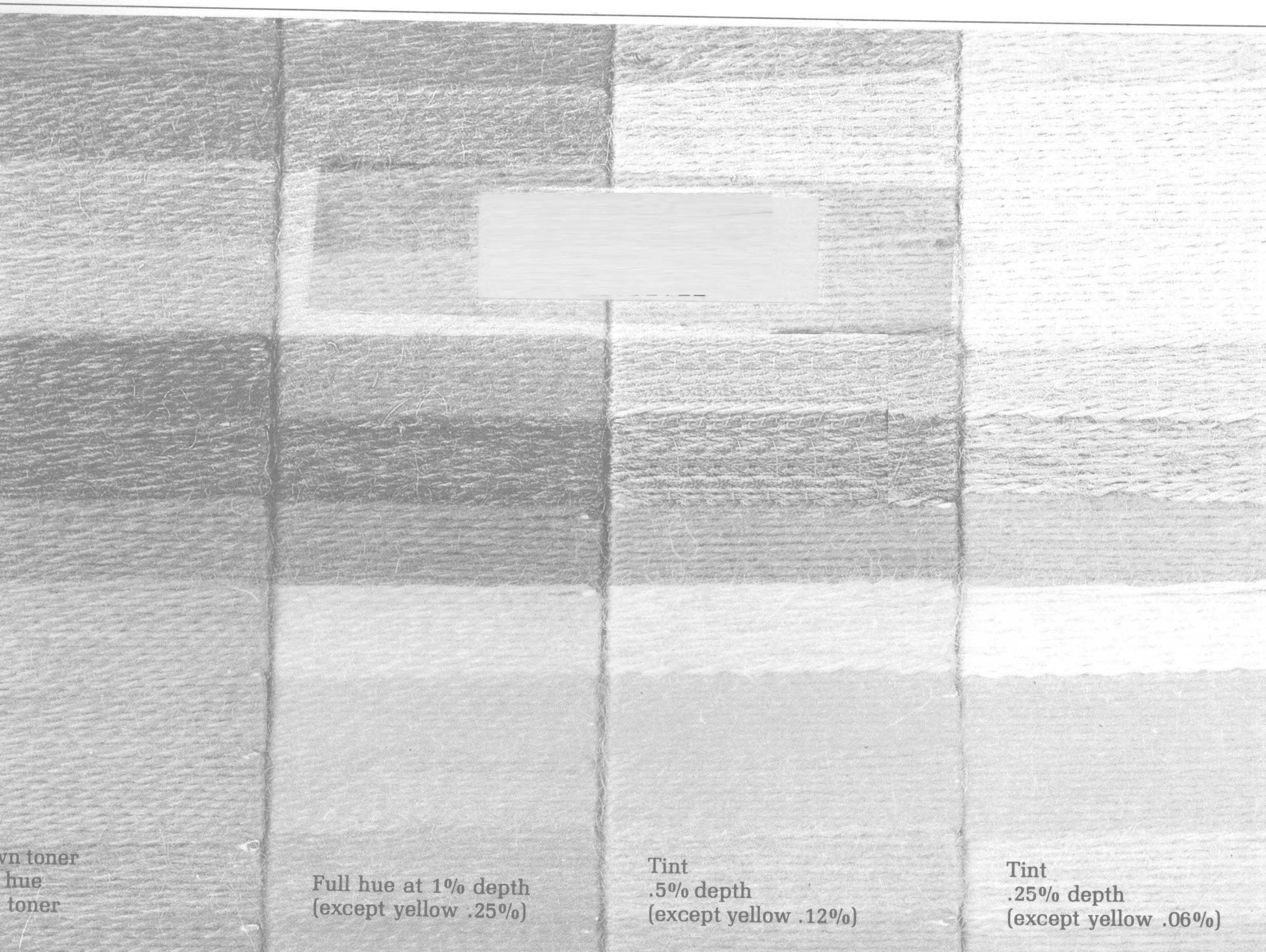

To our husbands,
Charles Vinroot and George Crowder,
for their faith in us.

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Neither the authors nor the publisher assumes responsibility for disappointing or harmful results incurred in using the methods, techniques and products described in this book.

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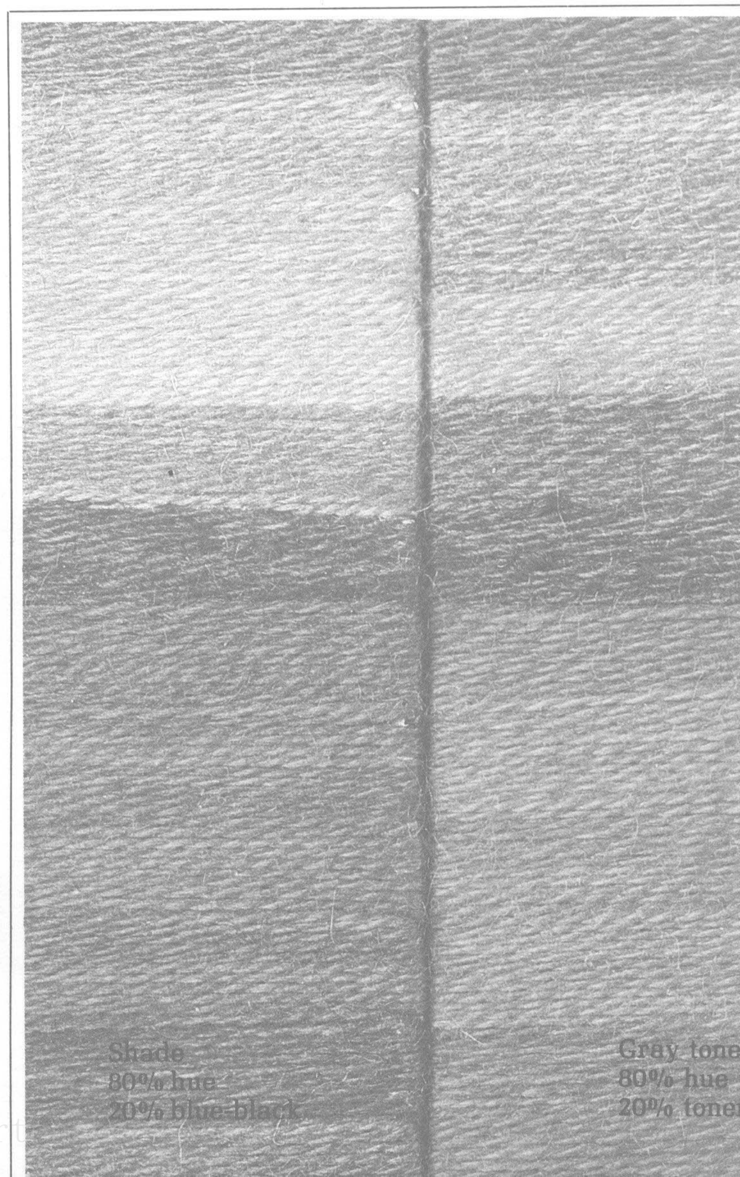

ACKNOWLEDGMENTS

This book is the result of several years' work and experimentation. Many people have helped us during this time and we would like to thank them.

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To our publisher and editor, Linda Ligon, we are indebted for her patience and expertise during the long process of polishing and rewriting prior to publication. She was largely responsible for the development of the color overlays from a printer's tool to a dyer's, which we hope our readers will find useful.

Finally, we would like to thank certain very special friends who tested dye procedures, read through drafts and freely gave both time and ear to this work. Rosemary Luckett, Rima Meyer, Lynn Baritelle and Lee-lee Schlegel were especially helpful, but many others were important along the way, and to all, we express our appreciation.

S.V. & J.C.

EDITOR'S NOTE

The manuscript for this book first came across my desk during the spring of 1979. It struck me immediately as a good book—substantial in content, direct in approach and definitely a contribution to the field of textile crafts.

Since I first read it, the book has evolved a great deal; it's almost twice as long, some chapters have grown, some have merged, others have disappeared entirely. All this evolution has occurred with the authors half a world away from each other; Jennie moved to Germany shortly after the first draft was written.

The sustained effort, the compromises, the many re-writes that have gone into the final version that you see here are a tribute to the authors' belief in their work, and their belief that the craft world is ready to take chemical dyeing seriously.

The color theory, technique and procedures, and dye chapters (II, III, IV, V and VI) are primarily Sally's work; Jennie is chiefly responsible for the historical and applications chapters (I and VII) as well as the fiber identification material in Chapter III. May the results of this collaboration be fruitful for you, our readers.

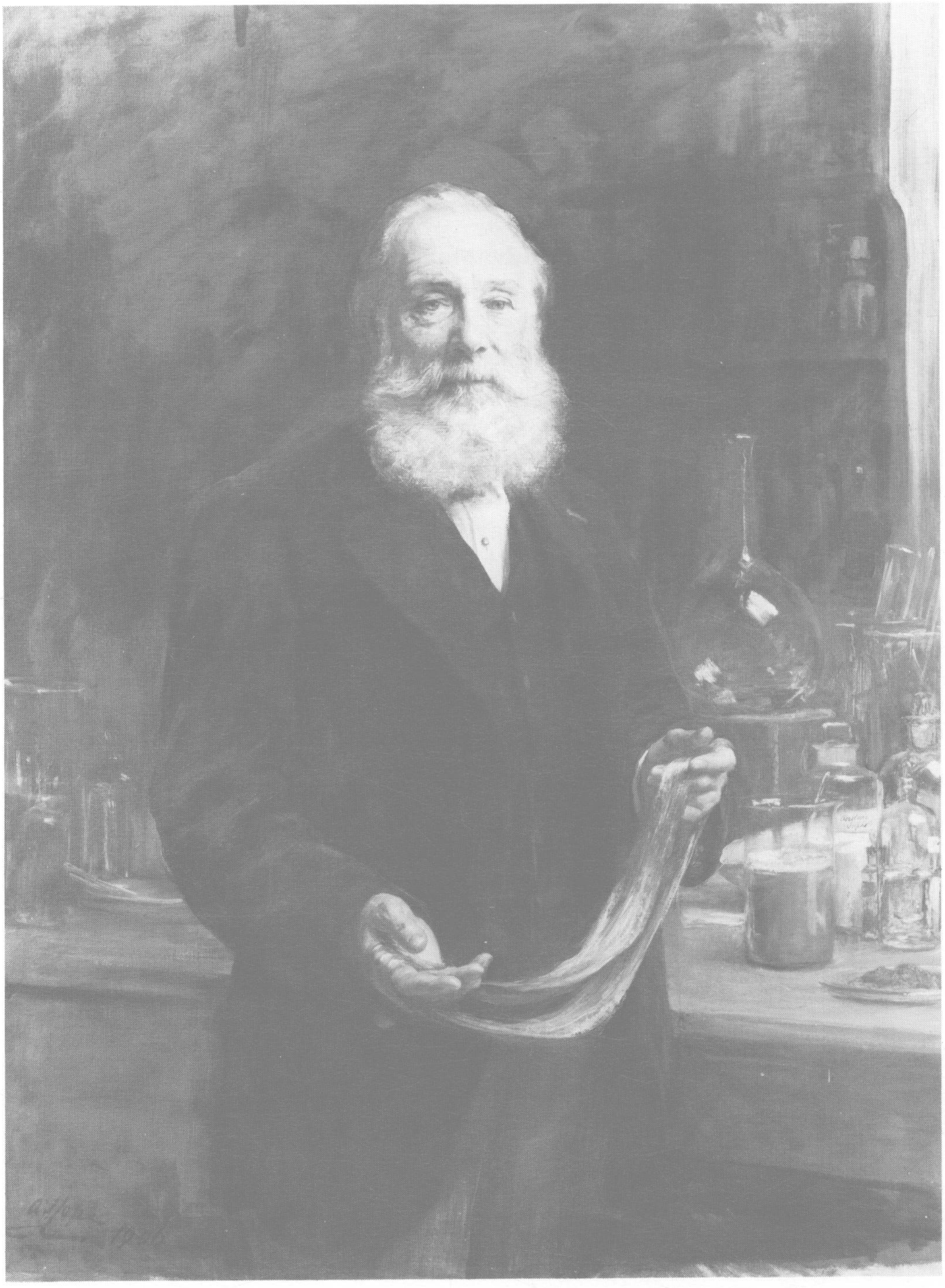
Linda Ligon

PREFACE

This book is intended to provide basic chemical dye knowledge and technique for the fiber craftsman interested in doing his own dyework. The background knowledge is designed to give the craftsman enough technical information to understand the processes and to deal intelligently with industrially-oriented suppliers, who often have the best selection and the best prices but not necessarily the most patience. The procedures are adapted from test lab methods because these are usually exact yet designed for small amounts of fiber. All dye manufacturers give directions for using their products, but even if these were available to the small dye worker, they would be difficult to use since they are slanted as much toward the type of machinery to be used as to the fiber to be dyed.

The 'machinery' recommended here for the studio/home dyer are common items found in hardware stores and kitchen shops. The chemicals needed to fix the dyes are very ordinary substances such as salt and vinegar found in grocery stores. However the more concentrated forms of these can be ordered from science supply houses and photography shops if desired.

Only three of the eight or nine major classes of chemical dyes are described here. These three were chosen because they are simple to work with and, put together, color a large selection of fiber types. Only 12 dyes are specified, namely a basic set of magenta, yellow, cyan and black in each of the three classes. This limitation is designed to encourage the beginning dyer to learn how to mix colors and also to control his costs, since dyes are going to be one of the biggest expenses in setting up a dye work center. Yet with these 12 dyes, as will be shown, thousands of hues can be produced on wool, silk, nylon, cotton, linen, jute, rayon, acetate, acrylic and other fibers and fiber blends.



Sir William Perkin, 1892. *Courtesy of National Portrait Gallery, London.*

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CHAPTER 1: Origin and Development of Dyes

Use of dyes in prehistoric times

Throughout history man has depended upon naturally occurring substances for coloring his textiles and leathers. These coloring substances came from plants, insects and other natural sources which gave chemicals that, when correctly processed, produced colors. Dyes have entered almost every part of our lives, as you would quickly realize if you visualize your everyday surroundings without color.

Dyeing really began when early man took notice of the color of his surroundings. Paleolithic man began by applying colored clays to his body in order to make himself more desirable and more effective in food gathering. Gradually color became part of a complex magical system which affected his life. It represented the animals that he hunted, and the plants with curative powers. Color was the enhancement that made the paintings on the cave wall more alive, and more representative of the real thing. Paleolithic man applied juices and colored clays to his possessions and body coverings. He applied bits of shell, colored stones and blood to himself and his clothing for decoration. Later, Neolithic man began to add decoration to his tools for aesthetic value only. This early man gave up the nomadic life and began farming; thus to replace the skins that he had formerly obtained from hunting in the past, he learned to weave cloth. He likely then applied old methods of decoration to his woven fabric.

Iron minerals from the earth gave yellows, reds and browns. Soot, coal and juices from certain plants were used for other colors. Neolithic man experimented with the magical properties of sea water, urine and other familiar materials to make those colors permanent. Gradually the more effective of these materials were separated from the less successful, and a formal concept of dyeing was born. After more experiments and more refinements the dyer had become a craftsman in his own right. He had obtained the knowledge of his craft—the knowledge of materials that work with a dye to affix the color to the fiber in a permanent fashion—a mordant.

Early examples of weaving from the ruins of Neolithic lake dwellers in Switzerland and the salt mines of Europe indicate that dyeing was at a fairly advanced state there by 4000 B.C. A garment dyed with indigo has been found in Thebes that is believed to date from 3500 B.C. Since the process of converting the indigo plant to dye is complicated, this is taken as an indication of the advanced state of the art of dyeing at that time.

Throughout history the dyer was considered inferior to the weaver and spinner. In some early societies there were exceptions, but only in the more highly structured ones. In simple cultures the spinner, weaver and dyer were one in the same, much like the pioneer American wife, who was so isolated that she often did all her own textile production.

The papyrus Anastasi, written in approximately 3200 B.C., describes the life of textile craftsmen in Egypt. The intent of that particular writing was to encourage the student to apply himself and rise above the life of a craftsman. The weaver was described as having a life: ". . . worse than that of any woman, his knees pressed against his stomach on account of his uncomfortable position. He can never breathe pure air. When his daily production is not sufficient, he is broken as a lotus in a swamp. If he wants to see the light of day he must give his daily bread to the guardian at the door."

Dyeing in the ancient Mediterranean cultures

According to the papyrus, the life of the dyer was equally unpleasant: "The Finger of the dyer has the smell of rotten fish. His eyes are red from fatigue."

During the period from prehistory to the Middle Ages, dyers became more adept at extracting dyes from the natural sources at their disposal. As trade increased between countries and continents, more effective and interesting dyes were added to the dyer's cabinet.

Dyes were an important part of the cargo carried over trade routes throughout the world. The Romans imported woad from England as a substitute for the precious indigo. Tyrian purple came from shellfish native to certain shores of the Mediterranean, and was an important trade medium for the Phoenicians. Safflower came from as far away as Asia and Africa. Madder was imported from Asia, as was indigo.

The Romans considered dyeing an important craft. Like other cultures they used color to denote rank, a custom which continues today in modern military and academic circles. In early Rome, purple from a rare and expensive mussel was used exclusively for the clothes of kings and priests. Later the privilege of wearing this Tyrian purple was extended to those who held political power in the republic. Gradually the wearing of purple became an outward badge of wealth and importance.

The first organization of dyers was formed as the Collegium Tinctorium by King Numa Pompilius, an early Roman. The dyers were subdivided into groups that specialized in the different kinds of dyeing—the *flammarii* dyed textile orange; the *violerii*, violet; the *crocotarii*, yellow; and the dyers that used the purple-bearing mussel were the *purpurarii*.

During the Dark Ages knowledge retreated to the nunneries and monasteries where the dyeing craft, among others, was kept alive. Here, as before, dyeing was considered subordinate to weaving. Gradually, as populations and commerce began to grow, craftsmen were selected for their abilities and the guild system developed.

At first, the aim of the guild was not to control the quality of the dyeing or to fix a standard for the fastness or application of the dyes, it was simply a co-operative formed for marketing a product. The guild system eventually became a large and powerful influence for quality and dependability. Another important function of the guild was to serve both as an educational source and a supportive group for the craft.

New World dyestuffs and dyers

The discovery of the New World and its new materials increased the number of known dyes, the most valuable of which were logwood, brazilwood and cochineal. In some instances the use of these dyes extended into the 20th century. Logwood, which gave a fast, deep, black to cotton proved an extremely valuable dye until after synthetic dyes were firmly established. Brazilwood, imported from the East Indies to dye reds, was discovered in abundance in South America by the Portuguese. They named the new land Brazil after the dye plant, from *braza*, red or fire.

Cochineal, an insect used by South American Indians for centuries, found a ready market in the Old World. It gave a red similar to the more expensive kermes from the Middle East. Cochineal and kermes are from closely related insect origins.

Early American dyers usually worked as part of the weaving or fulling industries. John Cornish of Boston, originally a wool teaser, then a fuller, became a highly respected and well known pioneer in the American dye trade. An inventory of goods taken after his death shows that he worked from a very limited range of dyestuffs. The list included gall, brasel wood (brazilwood), madder, fustic, green vitriol and some auxiliary materials.

The first book on dyeing published in the United States was written by Asa Ellis, and was titled *The Country Dyer's Assistant.* It was published in 1798 in Brookfield, Massachusetts. Ellis stated that he was presenting the book "as the result of 20 years practice and unwearied pain and expense." His book was the first to list measured dyestuffs and define the results that the dyer could expect, a large step forward in the direction of color reproduction.

Effect of the industrial revolution

Beginning in the 1700's great improvements were made in textile manufacturing. The industrial revolution really began in textiles, spreading from there into other industries. The output of the new textile factories was more than the finishers could process. Improvements in one branch of textile production led to, or forced, improvements in the others. The fly shuttle made it possible for a single weaver to make wide yardage which had previously required two-man weaving teams. The Jacquard loom expanded design possibilities. The spinning Jenny and later adaptations of it produced yarn in quantities impossible for handweavers to absorb. Power looms evolved to utilize these yarns. At the same time, an expanding population and resulting need for textiles consumed the cloth which was pouring off these new looms.

During the first half of the 19th century, methods of cleaning and bleaching fibers were refined. Mordants were produced by more exact methods and techniques and equipment began to change in all areas of textile manufacture. However, dyeing was still done in much the same way that it had been for hundreds of years.

The early dyes were what we call "natural dyes" today. With more and more cloth being manufactured, it became more and more difficult to produce enough natural dyestuffs to color it all; the time was ripe for the development of synthetic dyes.

Development of synthetic dyes

The intellectual climate in which synthetic dyes were conceived was very different from that of today. At that time there was a prevalent belief that only living organisms could produce organic substances. As a result, even though there were efforts by government and industry to stir science to manufacture substitutes for natural dyes, scientists did not apply themselves to the problem. However, when Friederich Wohler succeeded in synthesizing urea from inorganic substances in 1828, chemists finally became convinced that they could succeed in manufacturing organic substances. It was in such a laboratory investigating synthesizing quinine, a drug to control fever, that the first dye was made.

In 1856 William Perkin was a university student studying under the brilliant German chemist von Hoffman in London. While pursuing synthetic quinine in a small home laboratory, Perkin succeeded in isolating a black precipitate that made a purple solution when treated with ethyl alcohol. After testing, Perkin became convinced that he had produced a good dye for wool and silk. He sent a sample for further testing to Puller's of Perth, a dyeworks, where they found that it did indeed make a satisfactory dye, providing it could be produced economically. This first synthetic dye was an *aniline*, a class of organic compounds made from nitrogen and benzine, and Perkin named it mauve or mauvien. Perkin used coal tar, a waste product from coal distillation in the gas works, as the raw material of his dye. Because of this origin, the early synthetic dyes were called coal tar dyes. Perkin and his family built the first synthetic dye factory, and only a year after his initial discovery he was manufacturing the dye.

This new discovery was a very large step forward in textile coloring. It was reasoned that if one dye had been synthesized then certainly more could be synthesized. Immediately, chemists from all parts of Europe began testing to find additional dyes. Perhaps of greater importance, this discovery helped to make chemistry a modern science.

The first dyes of the aniline family tended to fade and run when washed, but their brilliant colors and low cost made them very popular. They belong to a class of dyes now called cationic or basic dyes. These have been improved over the years, and are among those now used to dye acrylics, polyesters and other synthetics.

Organic chemists continued experimenting to obtain more and different colors. The first natural coloring agent isolated and synthesized was alizarin, the red in madder. Two chemists in Germany, Graebe and Libermann, applied in 1868 for the patent on this process just two weeks before Perkin in London. Soon it was found that by modifying the chemical structure of this group other colors could be made. With the introduction of manufactured madder, cultivation of the plant declined greatly, ruining the natural madder industry. Since the French were large suppliers of this natural dyestuff, many French farmers converted the land where they had grown madder to the growing of grapes. This land conversion helped to expand a fine wine industry.

Later, indigotin, the colorant in indigo, was synthesized by Von Baeyer. He first established the chemical structure of indigo in 1880, but did not manufacture the substitute indigo until ten years later. Like madder, indigo cultivation was severely affected, and the land was returned to food production. Synthetic indigo alone freed over one million acres in India in the 10 years from 1886 to 1897. These substitute indigos, which are vat dyes, were the first dependable synthetic dyes for cotton. Other dyes were difficult to apply and did not give a good fastness on cotton. Although expensive, the vat dyes were bright and attractive, and very fast to light and washing.

In 1858 Griess discovered what was to be called the diazo reaction which gave rise to a large range of dyes known as the azo or napthol dyes. Although not developed until after 1870, they heralded a long series of dyes for dyeing cotton without a mordant. The dyes were fast to light, but did not have a resistance to washing or wet processing. They are still in limited use today, having been improved with chemical controls and after-treatments.

The 20th century saw the development of two very important dye groups, the disperse and the reactive. The disperse dye family was initially developed to dye cellulose acetate. This new fiber had no affinity for the traditional synthetic dyes, but it did have some attraction for the basic dyes. The colors produced by the basic dyes on rayon were not fast, and they proved to be expensive. Most of the dye was left in the dyebath and wasted.

Experiments determined that the acetate fiber would take up certain types of insoluble particles or basic dyes suspended in water. Chemists found that if they presented the dyes to the fiber in insoluble form the fiber would then take up the dye. This development led to a whole new class of dyes, the disperse. As more and more man-made fibers were manufactured the disperse dyes became more important and in many cases were the only colorants that would dye the new fibers. This class of dyes is very important in industry today. They are bright, have good light and wash fastness and are easy to use.

The most recent dye discovery is the fiber-reactive dye class, often simply called reactive dyes. Until the discovery of this group the dyeing of cellulose fiber depended on converting a soluble dye to an insoluble color after the dye had been absorbed by a fiber. The reactive dyes actually bond to the fiber molecule making reactive dyes one of the most fast dye groups for celluloses. These dyes are easy to use and give a good range of colors.

Synthetically produced dyes must meet the high standards of the industry. They are highly controlled during the manufacturing processes in order to give a consistent shade, wettability and strength. These controls insure that the subsequent deliveries of dyes will be the same as those which preceded them.

Union dyes such as Rit, Tintex and Cushing are not actually a separate class of dyes; rather they are a mixture of several classes, designed to dye as broad a range of fibers as possible. Often they are not as satisfactory as a dye specific to the fiber being worked. They have a tendency to fade and wash out easily. Some synthetic dyes, such as alazarin and indigo, are chemically identical to the coloring agent in the natural source, but in purer form. Natural dyes do not have the same purity of color and dependability of strength because they contain many other substances besides the pigment. The early natural dyes served well for centuries and continue to be useful to craftsmen. However, it would be impossible to dye all of the textiles needed today with natural dyes only. The quantities involved would be tremendous, and the environment would be bare.

Many of the methods developed during the search for new synthetic dyes were applied to other areas. For example, new medicines were found which gradually replaced the historically ancient plant extracts. Much later, plastics appeared. So more than dyes have come out of Perkin's 1856 discovery. An entire new branch of science, organic chemistry, has evolved.

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