CHAPTER III

STUDY OF COTTON MATERIALS

INTRODUCTORY

Work in sewing should also include a study of materials. It is not only of interest to know something about the fibers from which our clothing is made, but it is of practical value as well, since each has distinct properties which adapt it to different uses. In order to judge between good and poor material, one must know the standards of purity and quality of the different fibers and weaves.

This course is, therefore, planned to include a brief study of the four common textile fibers—cotton, linen, wool, and silk. It can be made interesting to children if it is made a live subject. If the relation is shown, wherever possible, to their geography, history, and composition lessons, all will be made more real and vital.

It is suggested that morning exercises be given to this work once or twice a week.

Evolution of weaving and spinning.—The textile art is older than man, for, long before
he came upon earth, spiders and caterpillars spun their threads, birds wove their nests, and certain trees formed a kind of cloth by closely interweaving the fibers of their inner bark. Man gradually conceived the idea of using this bark for clothing, by soaking it in water and beating it with wooden mallets to felt the fibers together; it was then dried and bleached in the sun, and colored with vegetable dyes, the method of coloring being to lay a leaf or flower on the dye and, as soon as the surface was covered with the dye, it was pressed down on the cloth, thus fixing the design. The bark most largely used for this Tapa cloth, as it is called, was that of the paper mulberry.

Perhaps the interlacing of the barks suggested other possibilities to the people of that day, for they began rudely to weave together reeds, rushes, and twigs to form baskets and mats, expressing their ideas of art and beauty by combinations of color and weave. Beautiful examples of primitive weaving are found in northern South America, Africa, and among our western Indians. With the discovery of spinning yarn the true textile art began, however, and, although there is no real information as to the actual time of the origin of spinning, we do know that it dates back before 2000 B.C. Early nomadic tribes used threads to
fasten together the skins which they used as clothing. Perhaps wool torn from the sheep in passing by bushes and brambles may have suggested it to them.

Until 1500 A. D. all spinning was done by hand and a spindle, which was at first merely a stick upon which the thread was wound. Later it was discovered that the spindle could be whirled around faster if it had a weight on the end, so a piece of wood was attached to the lower end. This was called the whorl. The need of something to fasten the wool to, brought the distaff, a stick around which the wool was
wrapped and then held in the hand or tucked in the belt.

At the end of the fifteenth or beginning of the

**Throwing the Shuttle Through the Warp Shed by Hand**
sixteenth century, a one-thread machine was invented which enabled the spinner to produce seven times more yarn than by the distaff and spindle. Gradually improvements and new inventions followed, so that today most of the spinning has been taken from women's hands and is produced by means of machinery.

As a natural sequence to the discovery of spinning came the weaving of the spun yarn. Linen cloth of exquisite fineness of thread and evenness of weave is found in old Egyptian tombs, and the early Greeks and Romans produced woolen fabrics of great beauty and firmness. Manufacture of both wool and flax existed in Greece in the days of Homer.

The early Egyptian loom was a vertical frame similar in idea to the tapestry loom, while some savage tribes stretched the warp threads between convenient objects on the ground or from horizontal supports and wove back and forth between the warp threads as in darning. Many modifications have come since the early days, but the same three steps to the process of weaving remain, whether the weaving be done on the crudest of hand looms or upon the most modern machinery: (a) shedding, the lifting of certain warp threads, thereby making a space, or shed, through which the shuttle is passed; (b) picking, passing the shuttle through the threads; and (c) battening,
pressing the weft thread against the preceding ones to make the cloth firm and even.

Cotton.—The cotton plant belongs to the natural order of Malvaceae, or mallow family, and is known scientifically by the generic name *Gossypium*. It is a shrub which reaches a height of from four to six feet, and is native principally to island and sea-coast regions of the tropics, although it can be cultivated up to about 37° on either side of the equator. A warm, humid climate and sandy soil are most favorable to its growth. In the southern states cotton is planted with a machine, the seeds being dropped in a continuous stream. When the young plant is about three inches high it is thinned out with a hoe, about twelve inches being left between plants. The time for planting depends upon the latitude, beginning about the middle of March and ending the first half of May.

Ten or eleven weeks after the planting the shrub is ready to bloom. The flower has five petals, yellow at the base and growing lighter in color at the edges. When the flower drops off a dark green pod is seen which increases in size and finally discloses a mass of downy white fibers in which are imbedded the dark brown or black seeds. The cotton is picked as soon as ripened and separated from the seeds by a process known as ginning. The seeds are hulled
COTTON SEEDS WITH LINT ATTACHED
and the kernel put through a hydraulic press which squeezes all the oil from it, leaving the meal, which is used for feed for cattle. The refined oil is used as a substitute for olive oil, the residue being used as soap stock.

The bales are wrapped in bagging and strapped with sheet-iron bands. When the cotton arrives at the mill, the bales are broken and the cotton starts upon its journey through various processes until it is made into yarn. The first step consists in giving the cotton a thorough cleaning, which is accomplished by a series of machines which pull the wads of cotton into shreds, beat out the dirt and any seeds left in, and finally leave the cotton in the form of batten upon the cylinders. From here the cotton goes to the carding machine where it is combed to straighten the fibers and remove any remaining foreign material and also some of the short fibers. Then it follows into the combing machine which casts aside as waste all fibers below a certain length, passing the rest on to the drawing machine where the fibers are laid perfectly straight and parallel and the cotton drawn out as much as possible without breaking. The combing process is omitted unless the cotton is being prepared for especially fine or high grade materials.

Several intermediate steps take place before the fiber is spun into yarn, the principal point
of difference being the amount of twist imparted to the strand. Spinning produces the finished yarn, which is converted into thread by uniting two or more yarns firmly by twisting. All sizes of 6-cord threads are made of six strands and 3-cord spool cotton is made of three strands. The ordinary spool of cotton thread contains 200 yards.

Before weaving into cloth, cotton threads are strengthened by coating them with a preparation of starch, flour, paraffin, tallow, etc., to enable them to withstand the friction resulting from the weaving process without breaking. After weaving, the material is bleached, starched, and calendered—the object of the last process being to give it a perfectly smooth and even surface and also to impart a luster to the cloth as it passes through. The cloth is calendered several times according to the finish required. (See below.)

Cotton is dyed either in the yarn or in the cloth, but it has much less affinity for dyestuffs than animal fibers, and, relatively speaking, there are only a few with which it can be dyed without the assistance of a mordant.¹

*Physical characteristics.*—Under the microscope the cotton fiber usually presents the ap-

¹ The term mordant comes from a word meaning “to bite.” It is a substance which will unite with the fiber and also with the dye to be used.
Pearance of a flat, slightly twisted ribbon with thickened edges. Physically the individual cotton fiber consists of a single long cell with one end attached directly to the surface of the seed. While it is growing, the fiber is round and cylindrical, having a central canal running through it, but, after the pod has ripened and
burst, the cell wall collapses, thereby causing the fiber to form into a flat, ribbon-like band. Upon ripening, the juices in the inner tube dry up, causing the characteristic spiral twist of ripe cotton. This spiral twist makes cotton valuable for spinning purposes as it causes the fibers to lock around each other more tightly. In diameter the cotton fiber is rather even for the greater part of its length, gradually tapering to a point at its outgrowing end. The length of different varieties of cotton fibers varies from $\frac{3}{4}''$ to $2\frac{1}{2}''$, sea-island cotton being the longest.

The hygroscopicity, or the power to absorb water without feeling damp, is between six and eight per cent of its weight. Cotton which has been freed from the natural vegetable wax is more hygroscopic and is known as absorbent cotton.

Linen has the greatest power of heat conduction and cotton ranks second. Materials made from linen are, therefore, the coolest and cotton comes next.

Though resistant to the action of moths and insects in general, cotton is acted upon by mold, as is evidenced by the formation of mildew on cotton fabrics stored in warm, damp places.

**Mercerized cotton.**—The process of mercerization is named after John Mercer, who in 1844 discovered that cotton might be given a
high degree of luster and at the same time strengthened by subjecting it to the chemical action of caustic alkali and a strong tension to prevent contraction.

When the cotton fiber is placed in the caustic

COTTON, MERCERIZED AND STRETCHED, SHOWING INCOMPLETE MERCERIZATION

solution it undergoes a peculiar physical modification, changing from the flat, twisted, ribbon-like shape to a smooth, rounded, cylindrical fiber with thickened cell wall. The tensile
strength is greatly increased, amounting in some cases to from 30 to 50 per cent.

Mercerization imparts a high luster to the cotton fiber due partly to the fact that the fiber, being cylindrical, reflects the light instead of absorbing it. Another condition which affects the lustrous appearance is due to the change in the cell elements. The substance becomes gelatinous and translucent, thereby affecting the optical properties of the fiber and lessening the amount of light absorbed. Ordinarily the process of mercerization is not continued until every fiber is completely mercerized. Mercerized cotton is somewhat more reactive towards dyestuffs than ordinary cotton.

Yarns of ordinary grades of cotton cannot be successfully mercerized, and as the cost of producing high grade mercerized yarn is about three times that of the same quality of unmercerized cotton, the higher cost of the finished product may readily be understood. Long-stapled sea-island cotton and Egyptian varieties are usually selected for the manufacture of mercerized materials, as they are better able to withstand the tension necessary for the perfection of the process than the short stapled fibers.

Cotton may be mercerized either in the yarn or in the cloth, although it is usually done in the yarn.
Silk finish.—Both mercerized and unmercerized cottons are often calendered to increase the luster of the material. The cloth is passed between rollers, under heavy pressure, one roller being engraved with obliquely set lines (125-600 to an inch). The large number of very fine parallel surfaces reflect the light, producing a beautiful silk-like luster. Unmercerized cotton which has been finished this way is no stronger than ordinary cotton.

A test for mercerized cotton.—Wash the samples, rinse well, and when dry compare with a piece of the same which has not been washed. If the luster remains, the material was mercerized. The finish put on by sizing material, pressure, and calendering is removed by washing.

Printing.—Block printing was first used, the design being engraved in relief on blocks of wood. These were dipped in the colored paste and applied to successive portions of the cloth by hand. These blocks are now replaced by engraved copper rolls, the design being such that it is repeated once or a number of times in each revolution of the cylinder. There is a printing roll for each color of the design. Sometimes both the background and the design are printed on the cloth, but the more common process is for the design only to be printed on the cloth, which may be dyed afterwards. In the
paste of the printed design there is some chemical which prevents the portions printed from taking the dye, consequently these remain white or a different color as the case may be. This is called the "resist" process. Another process is first to dye the cloth and then print on some chemical which, when the calico is steamed, discharges the color. This is called the "discharge" process. Sometimes this weakens the goods in the places where the color has been discharged. This accounts for the dropping out of dots and also the giving way of white stripes in printed materials. The color paste contains both the dye and the mordant. After calico has been printed it is steamed to develop and fix the color, washed to clear the white, usually sized and then pressed and dried by passing over slowly revolving, steam heated drums. In general printed materials are not so fast to washing and sun as those dyed in the piece or yarn.

The subject of dyeing is a large one and too technical for treatment here. The commercial dyes on the market give satisfactory results when the directions are carefully followed. The colors are usually harsh, but with a little knowledge of mixing colors, very pleasing effects may be obtained. A small sample of the material to be dyed should always be tried out in the dye
solution to make sure the color is right before the entire piece is immersed.

Testing: For fastness to sunlight.—Cover one end of a sample of material with a piece of heavy cardboard and expose the uncovered end to the sunlight for a number of days, examining it in the shade to see if the exposed end has changed in color from that of the covered part. Note the number of days it takes to change the color. Fabrics that are but slightly changed at the end of a month are called "fast"; "moderately fast" colors are those but slightly faded in 14 days; and those which are more or less completely faded in 14 days are called "fleeting."

For fastness to washing.—Fabrics should withstand the action of soap, the heat, and the mechanical friction necessary for laundering. To test the fabric wash it in a soap solution similar to that used in the household, not warmer than 131° F. Repeat several times and if the color does not fade it is fast to washing.

For crocking.—Many dark colored cottons which have been poorly dyed discolor other garments or the skin. Materials may be easily tested by rubbing them briskly on white un-starched cotton fabrics.

For per cent of shrinkage.—Pour boiling water over a sample and leave it immersed over night. Dry at a moderate temperature without
stretching. Press. Measure before and after treatment. In the home the folded material may be immersed as given above and then hung on the line to dry without wringing. This keeps the material in good shape and little pressing is necessary.

**Wearing qualities compared with price.**—Cotton, being cheapest, is not adulterated with any of the other fibers, but an inferior grade of material is often made to appear heavier by the addition of dressing. Starch, glue, dextrine, etc., are used, and they may add greatly to the weight of the cloth. The spaces between threads are filled and a good finish is given to the material, but after washing the cloth loses both in weight and firmness. This dressing may be detected in thin fabrics by holding them up to the light, the starch showing between the threads. Also by rubbing the material in the hands it is freed from part of the dressing and one may determine the firmness of the cloth. Still another method of determining the amount of sizing present is that of thoroughly washing a sample of the material and comparing it with the original.

If the material is to give good service, the warp and weft threads must be in good proportion. Materials having some heavy threads, as dimities, or having a much heavier warp than weft, are apt to split because of the unequal ten-
sion. Materials which have been on the market for some time may have become weakened by the action of the chemicals which were used in the bleaching or in the sizing.

The strength may be judged by the following test:

Place the thumbs together and press them down hard on the material, holding the cloth tight underneath. Consider the amount of strain resisted.

In choosing between two grades of the same type of material, consider the additional wearing qualities obtained for a slight additional cost. Often a piece of material costing two or three cents more will wear twice or three times as long as the cheaper material. This is not always true, however, as sometimes a large part of the price is represented in the novelty of weave, design, or color.

The firmness of the weave and the quality of the fiber are always important factors to consider. To judge the quality of the fiber untwist a thread of the cloth and notice the length of the separate fibers. A long fiber indicates strength and, therefore, good wearing qualities, other things being equal.

Always consider width as well as price in comparing two pieces of material. The wider material will usually cut to better advantage, and may, therefore, be more economical.
In purchasing dotted Swiss be sure to determine whether the dots are embroidered or merely printed or pasted on. Printed dots are more likely to fade and those made of paste become discolored by ironing and wear off.

Suggestive Review

1. Early history of the textile industry.

2. Cotton—growth and manufacture, where grown; necessary climatic conditions; correlate with the geography of the southern states. Picking, ginning, baling, cleaning, carding, combing, spinning, and weaving. What effect did the invention of the cotton gin have on the history of the United States?

3. Properties of cotton fiber—appearance under the microscope (what caused the twisted appearance), hygroscopicity, heat conduction. Mercerized cotton—how different from ordinary cotton, what physical change increases the luster and makes the fiber stronger?

Compare mercerized materials with those which have simply been calendered or treated to give them a lustrous finish.

4. Study of cotton materials—learning names, uses, and prices of the common types. Tests for quality; comparison of wearing quality and price. Get hold of as many samples as possible to use as illustrative material.
Remember that in all the study of fibers, the main idea should be to give to pupils practical knowledge which they can use in buying materials.