CHAPTER 1

THE TECHNICAL BACKGROUND.

It is not possible to interpret the evidence for textiles which may be found on excavations without a proper understanding of the materials and equipment needed, and the processes involved.

It is a lack of this information which has given rise to such curious phrases as "spindle whorls for weaving", 1 and has caused most Greek spindle whorls to be published upside-down. 2

This section of the thesis is written in the hope of eradicating such confusion by providing a working knowledge of textile crafts, as they are most likely to have been practised in prehistoric Greece.

I - THE MATERIALS

Raw materials are the first prerequisite, and with the exception of one or two important animal fibres, almost all of these are of vegetable origin. Trees and plants not only provide many different kinds of fibre for cloth, and twigs and strands for baskets and mats, but are also the source of nearly all the major pre-aniline dyes, and even of some of the scouring agents used in the preparation of wool.

Consequently some knowledge of ancient botany is necessary, and this immediately underlines the uncertainties which bedevil this subject, and indeed all archaeology.

Our present knowledge of the plants that existed in Greece between ten thousand and four thousand years ago is scanty indeed, and the means of increasing that knowledge may not be available for many years to come, if ever. Pollen analysis is still in its infancy, and conditions in Greece are not in its favour. Wood identification is yielding very interesting results, but is only just beginning to be employed, and is of course confined to trees and woody shrubs. The identification of seeds found on excavations, and the use of such methods as water-sieving and flotation have only just become fashionable; and interest is largely concentrated on the seeds of cereal crops.

Even from such meagre evidence, it is possible to confirm that a few of the species which are utilised in textile manufacture were available in prehistoric Greece—naturally it cannot be proved that they were used. Other species which are known to have been employed for the production of textiles in the ancient world beyond Greece, grow in Greece today. Yet others are, or were until recently, both grown and utilised in present day Greece.

It therefore seems worthwhile to state the present botanical situation, qualified where possible by information from the past, but in doing so one must take into account the changes which may have taken place in Greek flora over the past four thousand years. Such changes may have been caused by climatic differences and variations, by the inroads made by grazing herds and flocks, by the erosion which often follows denudation of the soil by this or other means, and by the man-made clearances.
required for organised agriculture. Finally, plants known to have been introduced in comparatively recent times must be excluded.

Actual climatic change may not have had a very influential role in the formation of Greek flora. Evidence on the subject is conflicting, and difficult for a layman to follow, but there does seem to be a strong body of opinion that there has been no major change in world climate since the end of the last glacial period, about 10,000 B.C. One authority even thinks "it may be a fair conclusion from pollen studies in Greece that no vegetational changes may be attributed with any certainty to climatic change." Even if there have been no great climatic changes within our period, however, minor climatic variations such as any one of us may witness in a single lifetime, may have an effect on plant life. This is particularly true of prolonged drought, and it need not by any means be of the magnitude of that postulated by Professor Rhys Carpenter.

A factor which must unquestionably have had its effect upon the plant life of Greece is the advent of the caprine species, the sheep, and the ubiquitous and almost omnivorous goat; but as their first incursions took place at the very beginning of the period we are considering, if not earlier, it is a factor which may be regarded as constant.

Man's interference is also a certainty, both in the destruction of some species, and the introduction of others. This can be readily understood as a general principle; and pollen analysis can provide an occasional specific instance, as in the findings from the Osmanaga Lagoon near Kyles.

Most of these factors are likely to eliminate old species rather than to add new ones. The plants which have remained are probably those which could survive the influences mentioned above. The species which 'take over' after deforestation in the Mediterranean, the bushes and scrub of the maquis and garigue, must have been as well-known to prehistoric Greeks as they are to modern ones, even if they did not then cover quite so much territory. Many of the plants with which this thesis is concerned come from these classes, while others, like flax, thrive best under cultivation, for which of course the land has to be cleared.

The Major Cloth Fibres.

Before the invention of man-made fibres this century, there were four major natural sources of fibre suitable for cloth, two of vegetable origin, flax and cotton, and two of animal origin, wool and silk. There were some other minor vegetable fibres, such as ramie, nettles, tree

1. H. E. Wright, Antiquity Vol. XLIII, 1968, pp. 126 - 128. The sudden decrease in pine pollen which occurred there about 2,000 B.C. may indicate the arrival of a new (shipbuilding?) people. Scrub oak appears to have replaced the pines. This would be to the advantage of textiles, as one variety harbours a dye insect, while another, the ilex, provides a wood suitable for loom frames.
bast, and certain kinds of moss, but there is no evidence that these were used in Greece in either prehistoric or classical times.

a). Flax.

Flax, the plant from which linen is made, was accounted the earliest fibre known to man until the recent discoveries at Çatal Hüyük. If M. L. Ryder is correct in his identification of the cloth from that site as linen, this could still be true, but the majority opinion seems to favour wool (page 31 below). Whichever is the case, flax was certainly in use very early. It is thought to be descended from a plant which is native to certain mountainous parts of the Near East and elsewhere. Although man may have made use of it while it was still in this wild state, it was already under cultivation in Iran and Mesopotamia as early as the sixth millennium B.C., and in Egypt at the beginning of the following millenium. This alone does not prove that textiles were being produced, as flax is often cultivated for its edible, oil-bearing linseeds as well as for its fibre, but from the fifth millenium B.C. onwards, there are remains of actual linen cloth, those from Brak and

Arpachiyeh in Mesopotamia and from the Fayum in Egypt being among the earliest. It was used for textiles in Neolithic Europe also, as is proved by the finds from the Swiss Lake Villages.

The earliest certain evidence for flax in Greece comes from Early Helladic Lerna, where a hoard of two hundred flax seeds was found. There are very few remains of cloth, and even fewer have been identified as linen. Traces are said to have been present in an Early Minoan deposit in a tomb on the little island of Mochlos. A scrap adheres to a dagger found in an Early Cycladic grave on Amorgos. A number of remnants, some of reasonable size, came from both grave circles at Mycenae; and a fragment was found clinging to a sword in the Chief Stair's Grave at Zafer Papoura near Knossos.

5. In only one of these cases is the method used for identifying the fibre given - some of the grave Circle B cloth from Mycenae was submitted to microscopic examination by the Greek archaeologist J. Papademetriou - Praktika 1951, p. 203; see also G. E. Mylonas "ΣΤΑΘΜΟΣ ΜΥΚΕΝΑ" 1973, pp. 22, Pl. 20, p. 4.
The decipherment of Linear B has made a welcome addition to this somewhat meagre evidence. Many of the tablets from Pylos appear to be concerned with linen, referring to it in such a way as to suggest an organised industry. They record the amounts of 'linen' owed by various settlements (whether 'linen' means flax or linen yarn or cloth is not clear); the allowances of 'linen' made to the different classes of employee; and exemptions from providing 'linen'. Among the professions mentioned is that of 'flax-workers'.

Only a few of the Knossos tablets are concerned with linen. One lists a linen cloak and tunic, and another, in a very persuasive transliteration, is said to record 'fine linen'.

The proportionate numbers of 'linen' tablets at Knossos and Pylos present an interesting and possibly significant comparison, for Minoan Crete, like modern Crete, may have been more concerned with the production of woollen cloth, (see below), whereas Messenia, the province in which Pylos is situated, was, until very recently, producing half Greece's total output of flax. As the flax being grown elsewhere in Greece, (chiefly in Macedonia), was often being cultivated for the linseeds rather than the fibre, the Messenian output of actual linen may have been rather more than fifty per cent.

The reason for this apparently remarkable continuity is not far to seek. Although flax seems to have originated in mountainous districts, its cultivation requires stretches of rich, loamy soil, and, above all, a plentiful water supply, both for the irrigation of the crop, and for the 'retting' stage of its processing. Very few parts of Greece can meet even one of these requirements, let alone both — but Messenia, well-watered and fertile to the point of lushness, is an exception.

The flax plant used for linen today is Linum usitatissimum, which is thought to be descended from a wild variety known as Linum angustifolium Huds. (Linum bienne Mill.). This occurs naturally in the Kurdish foothills, and seems likely to have been domesticated in the vicinity, and to have spread subsequently into temperate Europe. Bundles of unworked fibre from the Swiss Lake Village sites have been tentatively identified as L. angustifolium. L. usitatissimum itself was cultivated very early. Its seeds have been found at the sixth millennium Iranian sites of Tepe Sabz and Tel es-Sawwan, and in the earliest levels of the neolithic Fayum sites in Egypt.

The flax plant is a hardy annual with a single long, straight stalk, thin, lance-shaped leaves, and a head of flowers, each of which has five heart-shaped petals, which, in the case of both *L. angustifolium* and *L. usitatissimum*, are of a beautiful sky-blue. These later give way to pea-sized capsules, each containing numerous flat, shiny, brown seeds. The crop is thickly sown to make the stalks grow tall and straight, and under these conditions the plants reach a height of three to four feet (Fig. 1a).

It is the stalk which provides the linen fibre, and a cross-section (Fig. 1b) will help to explain its construction. It consists of a series of concentric rings of different types of matter, and it is the second of these, the cortex, which is of value. The cortex consists "of longitudinally disposed bundles of linen fibres embedded in gummy material which separates the bundles from each other, yet holds them together. Each of these fibre bundles extends the full length of the stalk, and each long fibre is built up of many short fibres joined end to end, with a slight overlapping of these ends." Each of these short fibres is only about two inches in length. The thickness of each fibre is about \( \frac{1}{1000} \)th of an inch. Throughout its length, a linen fibre is notched at intervals, and this, under magnification, looks rather like the jointing on a bamboo cane. It has a tendency to split into fibrillae, especially at the ends. The intermeshing of these fibrillae gives added strength to thread spun from linen, which is in any case the strongest of the natural fibres.

2. Information on the structure of the flax plant is largely derived from A. J. Hall 1963 op. cit.
The length and strength of the linen fibre must have made it an attractive one for early spinners, but the effort required to extract the fibre before spinning can begin is considerable. The many steps of the processing cannot be avoided, so that flax preparation in both ancient and modern Greece must perforce have much in common.

Although flax-growing is dying out rapidly today even in Messenia, because of the advent of man-made fibre, a generation ago it was being produced in a number of smaller centres, and among these was the island of Kephallinia. Mrs. H. Cosmetatos, of that island, in the course of setting up a folk museum there, collected a great deal of information on flax-working from the older members of the community. The following account is based on her research, and I am very grateful to be allowed to include it in this thesis. Mrs. Eleni Kotsaki and the other inhabitants of Paniperi in Messenia, one of the few villages still growing flax, confirmed much of her account, and Mr. Spiro. Zervas of Petalidhi, Messenia, provided some supplementary information. I am much indebted to them all.

Flax seed is planted in August or September in rich, well-watered soil such as that suitable for legumes. The plant flowers in April/May, and when it is fully grown, and the seed capsules have developed in May/June, it is up-rooted, two or three plants being pulled at a time. (There have been attempts to mechanise this process, notably in Northern Ireland, but they have not been particularly successful, and the best quality flax still has to be 'pulled' by hand).
Each of these small handfuls of plants is tied with a wisp of flax, and beaten on a stone to remove the seed; this is afterwards winnowed on the threshing floor, and stored away for next season's sowing. An instrument like a large wooden pestle, about thirty centimetres long, is used for the beating.

The useless roots of the plants are also hacked off with a small axe.

Eight or ten of the small bundles are then tied together into larger sheaves for the retting. The flax stalks have to be soaked in water for ten to twenty days to rot the green part of the plant. This can be done in a dammed-back stream or in a deep hole in the ground lined with unmortared stones. As the stalks start rotting they release a gas, and have to be weighted down with large stones to prevent them floating. It is advisable to ret flax at some distance from living quarters, as the stench of the gas is quite nauseating. Retting is the most important part of flax processing, the one that requires the most judgment, as if it is under-retted the fibres will not separate easily from the woody casing, while over-retted fibres are brittle and inclined to snap.

When the green parts are sufficiently rotted, the sheaves are taken out, untied, and placed upright singly in the sun to dry, which takes a day.

Next, the dry stems have to be beaten to finally remove the outer husk and the woody centre, and free the fibres. This is done on a device called a mangano (Pl. I).
A mangano consists of a long, rather narrow billet of hard wood, over half of which is fitted a lid, which is joined to the centre of the main part by a loose swivel joint. The effect is of a pair of scissors with two blades but only one handle, or of a crocodile's jaws. The underside of the lid and the corresponding upper side of the mangano have two divisions. In the part which is nearer to the joint, both the lid and the base are equipped with wooden teeth which interlock when they meet. The bottom of the outer part, however, has a raised, smooth, rounded piece of wood running along the centre of its length, and the corresponding portion of the lid is hollowed out to fit over it - to pursue the crocodile image, as the hard palate fits over the tongue.

The operator seizes a good fistful of the dried stalks and lays them over the serrated half of the mangano, then beats the lid smartly up and down on top of them, pulling them through the machine meanwhile, so they are well beaten all along their length (Pl. I). This is continued till all the woody part of the flax has been beaten away, and only the fibres remain. These fibres are then placed on the smooth half of the mangano, and beaten solidly for as long as fifteen minutes to make them soft and supple. After this they are twisted into a hank, which is laid on a stout wooden bench or a stone, and beaten yet again with a thick-ended wooden pestle. (Flax endures so many beatings during its preparation that the process is sometimes referred to as τὰ πάθη τοῦ λίνου - the sufferings of the flax).

The next stage is carding or combing. The combs used in Kephallinia were square pieces of wood, with a sheet of metal studded with nails on one side - like a
hairbrush with iron bristles. They are still used in other parts of Greece for combing wool. A hank of flax is placed on one set of nails, and the other is combed over it until all the fibres are separated. At this stage the flax on Kephallinia was divided into two qualities, fine for clothes and sheets, and coarse, for sacking, matress covers and other heavy duty cloth.

On Kephallinia again, the flax was spun in two different ways. The finer quality was formed into a rove which was carefully folded round a special, very intricately-fashioned distaff, while the coarser fibres were pushed in a loose handful onto the ordinary forked distaff used for wool. The flax fibre tends to rotate in an 'S' or anti-clockwise direction when drying, and consequently needs to be spun in the same direction, otherwise it is inclined to unravel; but it is not recorded whether the flax in Kephallinia was spun in this, or in the normal Greek 'Z' or clockwise direction.

After spinning, the yarn may be bleached by being soaked in boiling water which has been strained through wood ash. It then needs careful rinsing, and is laid over canes to dry.

1. The people at Paniperi were only going to use their flax for olive pressing sacks, so they were not going to separate their fibre into two qualities.
2. A long coil of fibres laid parallel; fibres so arranged are easier to spin, and the resulting thread is less likely to have irregularities.
3. Made from bamboo, split and folded back so as to form a double dome. This could then be covered with a fine animal bladder to ensure smoothness.
4. I have never seen a Greek spin otherwise than in the 'Z' direction - but I have never seen anyone spinning anything but wool.
5. This method is good for bleaching clothes and sheets too.
All the stages of flax preparation described above, the sowing, the pulling, the seed collection, the root-cutting, the retting, the drying, the multiple beating, the combing and separation of the fibres, the spinning and the bleaching - must have taken place in the ancient world, including Greece, and it makes the very early occurrence of linen cloth all the more remarkable.

The only process which may have changed slightly is the beating. Conditions in Greece are no more conducive to the preservation of wood than they are to that of textiles, so that a mangano, if used in antiquity, could not be expected to survive. The same cannot be said of Egypt, however, and there is no mention of such a machine in Petrie's comprehensive "Tools and Weapons", nor does there appear to be one in any of the many scenes of textile production that decorate Egyptian tomb walls. Yet some similar instrument there must have been, for the action of a mangano is not one of simple beating, such as may be provided by a pestle on a stone, but rather a combination of chopping and beating.

With this exception, the above account of practices in rural Greece may serve to illustrate the processing of flax during the period covered by this thesis.

b). Wool.

Wool in some form was available to man very early in his history. The problem is whether he availed himself of it for cloth-making within the prehistoric period, or not.

One authority holds that the earliest evidence for agriculture in the Near East takes the form of domestication of sheep, followed by that of goat, and that this was accomplished between 9,000 and 7,000 B.C.

Sheep bones have been found on almost every excavation in Greek lands, and certainly on many of the earliest sites. Caprine bones are recorded from the paleolithic cave at Kastritsa, south of Ioanna in Epirus. They occurred at the Early Neolithic site of Nea Nikomedea in Macedonia, and at pre-ceramic Argissa in Thessaly. They were introduced at Franchthi, a cave site on the Troezen Peninsula, at the same time as the first pottery, or perhaps a little earlier; and were found in Early Neolithic levels dating to circa 6,000 B.C. at Knossos.

The problem of the first proven use of wool is a very vexed one. Previous to the Çatal Hüyük finds, most authorities stated that the earliest woollen remains were the Scandinavian ones of the twelfth century B.C., but this overlooked the examples found in Egypt, dating

from predynastic times to the New Kingdom. Mesopotamian tablets list wool prices from the end of the third millennium B.C. onwards, indicating that sheep there were valued as more than merely a source of food; and a strong case has been made out for a woollen industry in Late Minoan Crete, based on the Linear B tablets from Knossos.

When first found, the very fine Çatal Hüyük textiles were considered to be of wool, and in spite of one strong argument to the contrary, the site's excavator seems to adhere to this opinion. As these are the world's oldest textiles, the correct identification of the fibre from which they were made is of great importance; but before the arguments for linen versus wool can be considered, it is necessary to consider the structure of wool, and its preparation for spinning.

Wool as we know it today consists of wavy or crimped fibres, each one of which may be between two and sixteen inches in length, and 1/300th - 1/1000th of an inch in diameter. The finest merino wool is about five

1. W. M. F. Petrie and J. E. Quibell "Nagada and Ballas", 1895, p. 24. It was knitted, not woven, stuff, and the possibility that it was intrusive is considered and rejected.
2. W. M. Flinders Petrie, F. Ll. Griffith, Percy E. Newberry "Kahun, Gurob and Hawara", 1890, p. 26. Remains were dyed red, green and blue, and there was also red-dyed fleece, unspun - XIIth Dynasty.
inches in length, and as little as 1/3500th of an inch in diameter.

Each woollen fibre has an inner core, called, as with flax, the cortex, and an outer sheath-like covering of closely overlapping scales, the epithelial scales, each of which has a slightly protruding edge pointing towards the tip of the fibre (Fig. 1c). It is the rough surface provided by these scales that gives wool its unique felting power, that cohesive quality which makes it very easy to spin. Hair has a similar make-up, but the scales are less prominent, and consequently it does not hold together as well as wool. Neither any of the vegetable fibres, nor silk, have this property.

Although wool is not as strong as either cotton or linen, it has the advantage of being three to four times more elastic, and is highly resilient. This also helps to make it easy to spin. Finally, like the other animal fibre, silk, it takes colour very readily, whereas linen is difficult to dye.

Wool is much easier to prepare for use than linen. It can be spun immediately it is removed from the sheep's back if one does not mind a few impurities - but it usually receives slightly more elaborate preparation.

Before the coming of iron and the invention of shears with opposed blades, wool is generally supposed to have been combed or plucked from the sheep, which were

sometimes kept fasting beforehand to loosen the roots of the fibres - but sheep which are not shorn shed their fleeces naturally at irregular intervals in any case. Flint and obsidian blades can sever locks of human hair, and there seems no reason why they, and bronze blades like daggers and razors, should not have been used to cut wool if desired.

Once the fleece was removed, by whatever method, it would have needed washing in (preferably hot) water with a mild alkali added, to remove natural grease, sweat, and collected dirt. Several endemic Greek plants, including Saponaria officinalis (soapwort) and Salsola kali are suitable for the purpose.

The wool would then have been laid out to dry, after which it may have been beaten with sticks, or perhaps with a bow-like instrument still sometimes seen in Greece, to soften it, separate the fibres, and to help remove impurities such as burs, which remain after washing.

Finally it would have needed combing to loosen and separate the fibres sufficiently for spinning. Wool combs of the type described as being used in the preparation of flax (page 23 above) are also used in rural Greece today for the preparation of wool, and it would be natural to suppose that similar instruments must have been in use in antiquity. No remains of any appear to have been found on excavations in Greece, however, and though the wooden parts would not survive, the metal parts could.

2. Largely derived from Elsa Gullberg and Paul Åström 1970 op. cit. A wool bow is on display in the folk museum at Plaka, the capital of the island of Melos.
The explanation may be provided by an incident which took place in Tylissos, Crete. I was asked to help comb some wool, and found I was to do it with my fingers. I asked about wool combs, and was told that while they are sometimes used, they are not really necessary; it seems that fingers were invented before wool-combs, as well as before forks.

The sheep from which the wool had been cut was a wild and shaggy animal staring suspiciously at us from the back yard. It had hair rather than fleece, and seemed to be no distant relation of the goat which shared its quarters.

The cut fleece contained both very long, coarse hair, and very fine short-stapled wool, the beast's undercoat. Our first task was to sort the fleece into these two classes, and the longer, smoother hair pulled away from the shorter, fluffier wool very easily. I was told the former would be put aside, to be used later for making carpets and saddle-bags. It was the fine wool that was wanted immediately, and when this was all in a separate pile, it had to be teased, ready for spinning. One took a good fistful in one's left hand, held it quite tightly, and from the small circle formed by the curled first finger and thumb pulled out a few fibres at a time with the other hand, each fibre as separate from the others as possible. This produced a light, fluffy mass, rather like fairy floss in appearance, which was placed on the distaff with no further ado. Throughout the work we were removing burs, small twigs, grass seeds and the like. I later helped with the same work in Macedonia, and the wool was 'combed'
in exactly the same way.

This brings us back to the Çatal Hüyük cloth. These textiles, when first found, were identified as wool, and a more detailed later examination by Harold Burnham generally agrees with this. He cites a microphotograph which appears to show up the typical epithelial scales of wool; he says the presence of nitrogen implies an animal rather than a vegetable origin; he points out that the fineness of the material could be accounted for by the coarser parts of the fleece being removed during combing, as I saw done at Tylissos. He remarks that bast fibres require long and complicated preparation, that linen is the only bast fibre fine enough to have made the textiles, and that no flax seeds were found amongst the many cereal grains from the site. Finally, one of the most cogent arguments, he points out that all the thread has been spun in the 'Z' or clockwise direction, the direction already mentioned (page 24 above) as being unsuitable for linen. Wool spins equally well in either direction.

M. L. Ryder, on the other hand, reports upon a number of scientific tests carried out upon the Çatal Hüyük cloth, and reaches the conclusion that flax was the raw material. In support of this theory, he says that the

3. In my opinion the undercoat of the Tylissos sheep could have been used to produce cloth as fine as the Çatal Hüyük specimens.
fibres in the thread lie flat and parallel, while, as we have seen, wool is crimped and wavy; that the average diameter of the fibres is comparable with that of fine flax and silk, but considerably finer than the finest wool known in the undercoat of the wild sheep; that various chemical tests which had given positive reactions on both modern and ancient woolen samples failed entirely on the Çatal Hüyük cloth; that a positive reaction for nitrogen was again obtained, indicating animal matter, but this is to be explained through contact with decaying human flesh, as the cloth was found in burials. Finally the fibres were boiled in an alkaline solution. Wool has very good resistance to acids, but is easily destroyed by strong alkaline solutions. This treatment, far from destroying the fibres, removed the black colour caused by the carbonisation of the cloth, and it was then possible to see under magnification a jointing or cross-striation in each fibre which is typical of flax (page 20 above).

The two sets of arguments are irreconcilable, and the raw materials which went into the making of the oldest surviving cloth must remain uncertain for the present. Possibly Hyder's closing, tentative suggestion that both wool and flax were used is the correct solution.

Whether it was used at Çatal Hüyük or not, it seems only reasonable to suppose that wool was employed very early for fabrics, in view of its many advantages. It is a portable supply of fibre, as a flock has legs, while a crop has roots; it requires little preparation, and is easy to spin; it mats or felts well; it is resilient; it is warm, and

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remains so even when wet; it is relatively waterproof, especially if left unscoured, or felted and shrunk to the maximum degree; and it takes dye very readily, whereas linen does not. All these features must have made it a very attractive textile fibre to mankind in early times - and man-made fibres have not so far succeeded in destroying its great popularity today.

c). Silk.

There is no evidence that the other two major sources of natural fibre, silk and cotton, were known in prehistoric Greece, and there are some indications that they were not.

Silk, derived from the cocoons of certain types of moth, is of two kinds.

True, or Chinese silk is obtained only from the Bombyx mori. The filament of the cocoon of this moth can be unreeled to its full length without its breaking, and therefore need not be spun. It was being used for textiles in China in the third millenium B.C., but remained a Chinese secret until the sixth century A.D., when a pleasant historical anecdote relates how the first silkworm eggs in the West were smuggled into the presence of the Emperor Justinian in a hollow stick. This type was therefore not known in prehistoric or even in classical Greece.

Wild, or tusseh silk may be derived from the cocoons of various moths which are native to India and the Mediterranean. This silk is much harder to unwind, and

1. R. J. Forbes "Studies in Ancient Technology IV", 1956, p. 67. It was known as an import in the Roman world.
short lengths of it have to be spun together to make a thread. Gisela Richter's suggestion that it may have been introduced into Greece in the fifth century B.C. has been confirmed by recent finds of silk cloth in a tomb of that date in the Kerameikos cemetery in Athens. These may have been imports. The first certain reference to its manufacture in Greece is Aristotle's account of Coan silk, which he seemed to regard as a novelty invented in Kos itself.

Sinclair Hood suggests that the Minoans may have had some form of Coan silk, and the idea is a pleasant one, for the Minoans would certainly have rejoiced in anything so beautiful, and, like wool, it would readily have taken the bright colours they loved. Unfortunately there is no positive evidence for this, and the negative evidence is against it. Not only has no silk been found in prehistoric Greece or Crete, none has been discovered in the surrounding countries in their equivalent periods. The fact that there is none from early Egypt, where so much cloth has been preserved, is particularly discouraging. Even wild silk only seems to have been produced in the Mediterranean area from the Hellenistic period onwards, and pure silk even later. The use of silk in prehistoric Greece therefore seems very unlikely.

d) Cotton.

The earliest remains of cotton cloth so far found

are those from Mohenjo-Daro in the Indus Valley, dating to circa 3,000 B.C. It appears to be indigenous there and in Abyssinia, Senegal and the New World, but not in the Mediterranean area. At the end of the eighth century B.C., King Sennacherib of Assyria had planted cotton trees in his park, and seems to have had at least one successful crop of cotton from them. Herodotus knew of the existence of cotton and cotton cloth, but in India. A piece of cotton fabric was found in a fifth century B.C. context in Greece, but was thought to be an import, as the writer claims that cotton was not grown in Greece in classical times. Alexander the Great's soldiers found it useful for stuffing their pillows on their eastern campaigns, which is perhaps a fitting commentary on Greek knowledge of cotton in antiquity. It is a thriving crop in modern Greece, especially in Thessaly.

Minor Cloth Fibres.

Other, minor types of plant fibre have occasionally been identified in ancient cloth remains.

4. Cotton seeds have recently been found in a neolithic context in Nubia, but they were apparently used for feeding stock, and it is not thought that cotton was utilised for textiles there till a much later date - K. M. Choudhury and G. M. Buth, Biol. J. Linn. Soc. Vol. 3, No. 4, 1971, p. 303 ff., W.B. pp. 309 - 310.
Hemp (Hibiscus cannabinus) was used in Egypt, and may have been one of the unidentified bast (plant) fibres used in some of the Badarian textiles. Although Herodotus does not mention it, it may have been grown in Greece in the fifth century B.C., as a piece of hempen cloth of that date has been found. It was certainly under cultivation in Hellenistic times, and Pausanias records it in Elis in his day.

Ramie or China Grass (Boehmeria nivea, b. n, tenacissima) is a member of the nettle family, and was used in ancient Egypt. Cloth made from it is said to be warm, and a possible substitute for wool. It now grows only in the Far East.

The common nettle (Urtica dioica), which may be seen everywhere in modern Greece, yields a fine fibre similar to flax, but not as strong, so that cloth woven from it does not wear as well. This again may have been the unidentified plant used for the Badarian textiles. The earliest cloth definitely identified as being of this fibre comes from eighth century B.C. Denmark, and it continued to be used for fine, open textiles till the middle of the last century.

5. Pausanias V, 5. 2.
Jute (Corchorus capsularis, C. olitorius)
flourishes in Bengal, and is unlikely to have travelled as far west as Greece in the prehistoric period, although the latter variety, imported from India, is cultivated in Greece today.

There is no evidence for the use of any of these materials in prehistoric Greece, but if any were employed, the common nettle is likely to have been the most readily available.

There are other sources of fibre amongst the plants and trees which grow in Greece today, and are probably endemic to the country.

The Spanish broom (Spartium junceum), in spite of its name, is amongst these. The relatively fine fibres that can be extracted from its stems is sometimes used today.

Other fibre-producing plants which now grow in Greece are: Butomas, Carex gleuca, Carex paniculata, Carex vulpina, Equisetum, Luzula, Scirpus silvaticus, Sparganium, Taxus baccata, Typha and Zoster marina.

3. X. A. Dimoula "Ελληνική Χλώρα" Vol. 8', 1939, p. 248, Χλώρα κλειστή.
The bast fibres obtainable from the inner bark of many trees can be used for matting, rope and coarse textiles, and among others, the birch, the elm, the lime, the pine, the poplar and the willow, all of which now grow in Greece, have suitable bark. Of these, the last five have left proof of their existence in prehistoric Greece also.

The fleeces, hair or fur of animals other than sheep provide minor sources of fibre. Of these, the one most likely to have been used in prehistoric Greece is goats' hair. It was available from the beginning of the Neolithic Age (page 26 above), and possibly earlier. It is not as easy to spin as wool, being less cohesive, but is very durable, and for this reason is widely used in rural Greece.

1. Χ.Α. Δικαστολή "Ελληνική Χλόη", Vol. 8, 1948, p. 620, No. 1830, (beula). It grows only as far south as 40° 48' latitude, and at heights of 1,600 - 2,000 metres.
3. Χ.Α. Δικαστολή 1948 op. cit., p. 310, Nos. 1064 - 1066, (tilia). Found principally in northern Greece, but also in Laconia and Achaia.
5. Χ.Α. Δικαστολή 1948 op. cit., pp. 514 - 515, Nos. 1820 - 1822, (populus). The widespread populus alba is found near rivers everywhere in Greece; while populus tremula is found on mountainsides to a height of 1,500 metres, again throughout the country.
6. Χ.Α. Δικαστολή 1948 op. cit., p. 512, Nos. 1810 - 1817, (salix). Many varieties are found near rivers throughout the country.
7. The lime flourished in Ípirus in post-glacial times - S. Bottema in E. S. Higgs et al., P.P.S. XXIII, 1967, p. 28. Lime elm and pine pollen were found at the Early Neolithic site at Nea Nikomedea in Macedonia; charcoal samples from the same site again indicated pine, and poplar or willow - Robert J. Rodden, P.P.S. XXVIII, 1962, pp. 274 - 276.
today for mats, carpets and saddlebags.

Textile Fibres - Summary.

Of all these fibres, the only one which can be incontrovertibly proved to have been in use in prehistoric Greece, is linen.

Wool does not survive in Greece as well as flax; while there are no definitely-identified woollen remains, its use is so highly probable as to be a moral certainty.

It is most unlikely that either silk or cotton was known.

The list of minor fibres is only a statement of possibilities.

Materials for Matting and Basketry.

Prehistoric Greek mats and baskets have survived only in the form of impressions on clay pot bases, so that none of the materials of which they were made has been identified. Therefore it is again only possible to suggest the materials which may have been used.

Many of the plant bastas already mentioned are suitable for matting - indeed flax itself may be used. Generally speaking, however, the strands used for basketry and mats are larger than those used for cloth, need little preparation other than the initial cutting, and are not usually spun.

1. It is sometimes possible to identify the materials used from impressions only e.g. G. M. Crowfoot, L.A.A.A. XXV, 1938, p.10.
Sedges, rushes, reeds, grasses and cereal straw were and are often used, also pliable twigs, and certain types of leaf such as palm leaves.

1. Sedges found in Greece include Scirpus lacustris and Scirpus litoralis, both of which were used for matting in Chalcolithic Palestine.

2. Among the rushes, Juncus acutus and Juncus maritimus are readily available. Juncus acutus was also among the materials used for the Chalcolithic Palestinian mats, as was the bulrush, Typha angustata, which is common in rivers, ponds and lakes throughout Greece.

3. The reed Phragmites communis, found all over the country today, is likely to have been in existence in Early Minoan Crete; it may have left its impression on a piece of roof plaster at the site of Fournou Korifi near Myrtos.

4. Esparto Grass, Lygeum sartum L., one of the most popular materials for basketry, is found all round Crete today. The other plant which goes by the name of

   It grows in marshy conditions in Macedonia, Thrace, the Argolid, Messenia, and the Ionian islands.

2. X. A. Δικαστική 1939 op. cit., p. 132, no. 362.
   It occurs in Thessaly, Aetolia, Attica, the Argolia, Crete and Corfu.


   It grows near the sea in many parts of Greece.

5. X. A. Δικαστική 1939 op. cit., p. 125, no. 335.
   Found along the seaboard in Macedonia, Thrace, Akarnania, Attica, the Peloponnese, Kephallinia and Crete.


7. X. A. Δικαστική 1939 op. cit., p. 245, no. 776.

8. Δ. Ζ. Καρβάλα "Η Χλωρίς της Ελλάδος" vol. 1, 1938, p. 344, no. 126.

9. Oliver Rackham "Appendix III - Charcoal and Plaster Impressions" in Peter Warren "Myrtos", 1972, p. 304 - "on balance, the reeds were probably phragmites."

esparto grass, *Stipa tenacissima*, is now confined to North Africa, although several other varieties of the genus *Stipa* do grow in Greece. *Stipa tenacissima* was used in Europe in the prehistoric period, as the baskets from the Murciélagos cave in Spain are of this material. It was also used by the Romans.

The stems of the Spanish broom, already mentioned as a source of fibre, can be used, untreated, for basket-making. Long, pliant twigs from trees such as the willow may also be employed.

Cereal straw of various kinds was obtainable in Greece from the beginning of the Early Neolithic period. Two kinds of wheat and one of barley were identified at preceramic Argissa, while at the other end of the country, wheat, emmer and barley were found at Neolithic Knossos.

The date palm, *Phoenix dactylifera* L., although not a native of Europe, may have been introduced into Crete from Asia or Africa early in Minoan times; its leaves were certainly used for mats and baskets elsewhere in the ancient world, but at present the evidence for

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1. X. A. Διαπονήθης "Ελληνική Αρχαιολογία" Vol. 1, 1939, pp. 209-210, Nos. 646-661
2. M. de Góngora "Antigüedades Prehistóricas de Andalucía", 1868, p. 31 ff.; Pls. I, II, Fig. 20; also well-illustrated in Max. Ebert "Reallexikon der Vorgeschichte" Vol. II (2), 1925, p. 338, Pls. 169, 170.
Matting and basketry in Neolithic and Minoan Crete is virtually non-existent.

Fortunately this is not the case elsewhere in Greece. Mat impressions are found from the beginning of the Neolithic period until the early years of the Middle Bronze Age, in numbers sufficient to indicate considerable activity, and many of the materials referred to above must have been in constant demand.

Dye Sources.

Sources of natural dye are so numerous that it is a case of embarras de richesse. In addition to the two important dyes obtainable from shellfish and an insect, those derived from plants run into hundreds. If the dye-yielding plants which now grow in Greece were available in prehistoric times, and, as previously remarked (pages 12-15 above) many of them must have been, anyone who wore 'hodden grey' did so from choice. Yellow dyes were probably the easiest to obtain, followed by red, and then black and brown. Blues and purples are likely to have been rarer. Green may have been the colour which was hardest to achieve, but one or two plants do yield a green dye, often a yellowish-green rather than a true green.

The body of material is so great that it must be dealt with in tabular form, with comments on only a few of the most interesting dye sources.

1. C. C. Edgar "The Pottery" in T. D. Atkinson et al. "Excavations at Phylakopi", 1904, p. 96, note 1, mentions one mat impression found at Knossos, and says "it has not yet been ascertained whether they are common in Crete." This is the only one I know of.
TABLES
OF
DYE SOURCES

ABBREVIATIONS:

X.E. - X.A. Διαπολή "Ελληνική Κλοός"


<table>
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<tr>
<th>Name</th>
<th>Habitat; Origins; Archaeological Evidence</th>
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<tbody>
<tr>
<td>Agrimonia eupatoria (Agrimony)</td>
<td>Woods, all parts mainland Greece</td>
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<tr>
<td>Anthemis tinctoria (Yellow camomile)</td>
<td>Barren places and street edges, many parts of Mainland Greece, and Corfu, Zacynthos.</td>
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<tr>
<td>Berberis vulgaris (Barberry)</td>
<td>In woods and near rocks, Macedonia, Thrace, Laconia, possibly Messenla.</td>
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<td>Calluna vulgaris (Ling)</td>
<td>In woods on poor to lime soils, Thrace, Macedonia.</td>
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<td>Caltha palustris (Marsh marigold)</td>
<td>Thessaly</td>
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<tr>
<td>Carthamus tinctorius (Safflower)</td>
<td>Mentioned in condiment list on Mycenae tablets (Myc. Docs. pp. 52, 58, 131, 226)</td>
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<tr>
<td>Centaurium erythraea (Common centaury)</td>
<td>Meadows near the sea, Thrace, Aetolia, Attica.</td>
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<tr>
<td>Chrysanthemum segetum (Corn marigold)</td>
<td>Peloponnese, Zacynthos, Crete.</td>
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<tr>
<td>Colchium autumnale (Meadow selfron)</td>
<td>Plains in Macedonia, Thrace.</td>
</tr>
<tr>
<td>Crocus sativus (Saffron Crocus)</td>
<td>Depicted on Linear pottery, frescoes. Crete, Cyclades and Dodekanese.</td>
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<td>Galium palustre (Bedstraw?)</td>
<td>Near bogs, swamps and springs, north Greece, Peloponnese, Corfu, Zacynthos, Crete.</td>
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<tr>
<td>Galium vernal (Lady's bedstraw)</td>
<td>Woods and meadows, Macedonia, Epirus.</td>
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<tr>
<td>Lunaria vulgaris (Common toadflax)</td>
<td>Barren plains and rocky places, Macedonia, Attica, Kephallinia, Laconia.</td>
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<tr>
<td>Lysimachia Vulgaris (Yellow Loosestrife)</td>
<td>Banks, shores and damp woods, Thrace, Macedonia</td>
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<tr>
<td>Pteridium aquilinum (Bracken)</td>
<td>Throughout Greece among woods.</td>
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<tr>
<td>Punica granatum (Pomegranite)</td>
<td>Stony places all over Greece, cultivated in many places.</td>
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<td>Habitat; Original; Archaeological Evidence</td>
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<tr>
<td>Pyrus communis (Pear)</td>
<td>Woods in Thrace, Macedonia, Epirus, Thessaly</td>
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<tr>
<td>Reseda luteola (Weed)</td>
<td>Barren places all over Greece. Probably a native of S.E. Europe. Found in Swiss Lake Villages.</td>
</tr>
<tr>
<td>Rhus coriaria (Sumach)</td>
<td>Areas of brush and scrub in Thrace, Macedonia, Thessaly, Attica (Mt. Parnes) Peloponnese.</td>
</tr>
<tr>
<td>Spartea junceum (Spanish broom)</td>
<td>Amongst rocks in the lower zones all over Greece</td>
</tr>
<tr>
<td>Spinacia oleracea (Spinach)</td>
<td>Semi-wild in Macedonia, widely cultivated elsewhere in Greece.</td>
</tr>
<tr>
<td>Verbascum thapsus (Aaron's rod)</td>
<td>In barren places and on the edges of woods in Macedonia, Euboea, Arcadia, Corfu, Zacynthos.</td>
</tr>
<tr>
<td>Vitex agnus-castus (Chaste tree)</td>
<td>Barren places by the sea and near banks of rivers, all over Greece.</td>
</tr>
<tr>
<td>Genista tinctoria (Dyer's greenweed)</td>
<td>Woods and meadows in Thrace, Macedonia, the Pindus, Athos.</td>
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<tr>
<td>Juglans regia (Walnut)</td>
<td>Self-planting in woods in Macedonia, Thrace and Epirus - cultivated all over Greece.</td>
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<tr>
<td>Chenopodium album (Goosefoot)</td>
<td>Found in Early Neo. Kea Nikomedeia, Middle Thessalian Argissa. In barren stony places all over Greece today.</td>
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<tr>
<td>Cotinus coggyria (Wig tree, smoke tree, Venetian sumach)</td>
<td>In brushy places all over Greece.</td>
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<td>Leaves B'</td>
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<td>Whole plant B'</td>
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<td>Dried leaves, B'</td>
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<tr>
<td>Bark and twigs</td>
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<tr>
<td>Flowers B'</td>
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<td>Leaves B'</td>
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<tr>
<td>Flowers B'</td>
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<td>B'</td>
<td>2096</td>
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<tr>
<td>Flowering branches</td>
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<td>Seed of nuts B'</td>
<td>1033</td>
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<td>B'</td>
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</table>

**DYER**

<p>| WOOD?             | B'           | 1152      | 334      | 706      |          |             |</p>
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<tr>
<th>Name</th>
<th>Habitat; Origins; Archaeological Evidence</th>
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<tbody>
<tr>
<td>Alkanna tinctoria (Dyer's Alkanet)</td>
<td>Barren places all over Greece. Used ancient Egypt, Mesopotamia</td>
</tr>
<tr>
<td>Asperula cynanchica (Squinancy wort)</td>
<td>Dry hills in Thrace</td>
</tr>
<tr>
<td>Asperugo procumbens (Madwort)</td>
<td>Barren places, roadsides, Thrace, Macedonia, Boeotia, Attica (Hymettos), Argolis, Messenia</td>
</tr>
<tr>
<td>Chenopodium album (Goosefoot)</td>
<td>Barren stony places all over Greece. Found Early Neo. Nea Nikomedea, Middle Thessalian Argissa</td>
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<tr>
<td>Echium italicum (Pale bugloss)</td>
<td>Uncultivated plains all over Greece</td>
</tr>
<tr>
<td>Galium palustre (Bedstraw?)</td>
<td>Near bogs, swamps and springs, north Greece, Peloponness, Corfu, Zacynthos, Crete. Known in prehistoric Europe.</td>
</tr>
<tr>
<td>Hypericum (St. John's Wort)</td>
<td>About two dozen varieties - all parts of Greece</td>
</tr>
<tr>
<td>Papaver rhoesas (Poppy)</td>
<td>In plains and fields all over Greece</td>
</tr>
<tr>
<td>Pistacia terebinthus (Turpentine tree, terebinth)</td>
<td>In lower zones all over Greece. Pollen traces in Osmanaga Lagoon.</td>
</tr>
<tr>
<td>Punica granatum (Pomegranate)</td>
<td>Stony places all over Greece; cultivated in many places.</td>
</tr>
<tr>
<td>Rhus coriaria (Sumach)</td>
<td>In scrubby areas Thrace, Macedonia, Thessaly, Attica (Parnes), Peloponness.</td>
</tr>
<tr>
<td>Rubia tinctorum (Madder)</td>
<td>Near hedges and in barren places all over Greece. Cultivated in some places, wild in others.</td>
</tr>
<tr>
<td>Taraxacum officinale (Dandelion)</td>
<td>Native of Syria, Palestine, and Egypt. Brought to Mediterranean.</td>
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## DYES

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<td>1153</td>
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<td>Roots</td>
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<td>Name</td>
<td>Habitat; Origins; Archaeological Evidence</td>
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<tr>
<td>Ligustrum vulgare (Privet)</td>
<td>Woods and bushy areas, northern and central Greece, Euboea, Achaea, Arcadia, Corfu.</td>
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<tr>
<td>Lycopus europaeus (Gypsy wort)</td>
<td>Damp places, river banks, all over Greece</td>
<td></td>
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<tr>
<td>Filipendula ulmaria (Meadowsweet)</td>
<td>Hill fields or plains, Thrace, Macedonia, Thessaly Arcadia</td>
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<tr>
<td>Populus Alba (Poplar)</td>
<td>By rivers all over Greece. Possible sample from Early Neoc. Nea Nikomedea.</td>
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<tr>
<td>Quercus coccifera (Kermes oak)</td>
<td>Scrub country, lower zones, all over Greece - see under Red Dyes.</td>
<td></td>
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<tr>
<td>Quercus aegilops Boiss. (Oak)</td>
<td>Lower zones up to circa 700 metres above sea level.</td>
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<tr>
<td>Sambucus nigra (Elder)</td>
<td>In cool, damp woods, and near hedges. North Greece and Ionian islands.</td>
<td></td>
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<tr>
<td>Vaccinium myrtillus (Bilberry, myrtle)</td>
<td>In woods and heaths in higher parts of Macedonia.</td>
<td></td>
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<tr>
<td>Xanthium Strumarium (Gall black, oak apples)</td>
<td>On oaks - all over Greece.</td>
<td></td>
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<tr>
<td>Myrtus communis (Myrtle)</td>
<td>In areas of evergreen broad-leaved shrubs all over Greece.</td>
<td></td>
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<tr>
<td>Humulus lupulus (Hops)</td>
<td>Near hedges, all over Greece</td>
<td></td>
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<tr>
<td>Origanum vulgare (Marjoram)</td>
<td>Woods, plains, north Greece, Corfu, Kephallinia, Euboea, Naxos.</td>
<td></td>
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<tr>
<td>Juglans regia (Walnut)</td>
<td>Self-planting in woods in Macedonia, Epirus; cultivated all over Greece</td>
<td></td>
<td></td>
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<tr>
<td>Betula pendula (Birch)</td>
<td>Northern Greece, at heights of 1,300-2,300 metres.</td>
<td></td>
<td></td>
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<tr>
<td>Juniperus communis (Juniper)</td>
<td>Olympus, Pelion, Parnassus, Taygetus, Millene, Athos.</td>
<td></td>
<td></td>
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<tr>
<td>Allium sp.</td>
<td>43 varieties all over Greece.</td>
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<tr>
<td>Berries</td>
<td>B¹</td>
<td>1064</td>
<td>34</td>
<td>312</td>
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<td></td>
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<tr>
<td></td>
<td>B²</td>
<td>2315</td>
<td>123</td>
<td>379</td>
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</tr>
<tr>
<td>Root</td>
<td>B¹</td>
<td>219</td>
<td>88</td>
<td></td>
<td></td>
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<td>53</td>
</tr>
<tr>
<td>Bark</td>
<td>B¹</td>
<td>1820</td>
<td>516</td>
<td>46</td>
<td></td>
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<tr>
<td>Bark</td>
<td>B¹</td>
<td>1343</td>
<td>523</td>
<td>53</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bark</td>
<td>B¹</td>
<td>1846</td>
<td>534</td>
<td>50</td>
<td>55</td>
<td></td>
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</tr>
<tr>
<td>Bark</td>
<td>B²</td>
<td>2314</td>
<td>202</td>
<td></td>
<td></td>
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<td>53</td>
</tr>
<tr>
<td>Fruit</td>
<td>B²</td>
<td>1580</td>
<td>6</td>
<td>299</td>
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<tr>
<td>Galls</td>
<td>B²</td>
<td>2823</td>
<td>263</td>
<td></td>
<td></td>
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<td>124</td>
</tr>
<tr>
<td>Fruit</td>
<td>B¹</td>
<td>209</td>
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**DYES.**

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<tbody>
<tr>
<td>Leaves, Flowers</td>
<td>B¹</td>
<td>1785</td>
<td>304</td>
<td>57</td>
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</tr>
<tr>
<td></td>
<td>B²</td>
<td>2286</td>
<td>116</td>
<td>364</td>
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<tr>
<td>Cut husks</td>
<td>B¹</td>
<td>1323</td>
<td>516</td>
<td>46</td>
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<td></td>
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<tr>
<td>Bark</td>
<td>B¹</td>
<td>1830</td>
<td>520</td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>Berries</td>
<td>A¹</td>
<td>55</td>
<td>54</td>
<td></td>
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</tr>
<tr>
<td>Outer skin of culb.</td>
<td>A¹</td>
<td>35</td>
<td></td>
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<td>54</td>
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<tr>
<td>Name</td>
<td>Habitat: Origins: Archaeological Evidence</td>
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<tr>
<td>Centaurea cyanus (Cornflower)</td>
<td>Rocky lowlands and foothills and among cereal crops, northern Greece, Aetolia, Peloponnese, Ionian Islands.</td>
<td></td>
<td></td>
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<tr>
<td>Chrozophora tinctoria (Tournesole)</td>
<td>Rocky places all over Greece</td>
<td></td>
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<tr>
<td>Isatis tinctoria (Woad)</td>
<td>Rocky places in Macedonia, Thessaly and central Greece. Native of eastern Europe. Used Mesopotamia and Egypt.</td>
<td></td>
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<tr>
<td>Mercurialis perennis (Dog's mercury)</td>
<td>Woods in Macedonia, Thrace, Euboea, Thessaly.</td>
<td></td>
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<td></td>
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<tr>
<td>Vaccinium myrtillus (Bilberry, blueberry, whortleberry)</td>
<td>Woods and heaths in the higher parts of Macedonia.</td>
<td></td>
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<tr>
<td>Origaniun vulgare (Marjoram)</td>
<td>Woods and plains northern Greece, Euboea, Corfu, Ithellinia, Naxos.</td>
<td></td>
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<tr>
<td>Vaccinium myrtillus</td>
<td>See above</td>
<td></td>
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<tr>
<td>Kurex orandaris, Kurex trunculus.</td>
<td>Mediterranean waters and elsewhere.</td>
<td></td>
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<tr>
<td>Chrozophora tinctoria (Tournesole)</td>
<td>Rocky places all over Greece</td>
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<tr>
<td>Genista tinctoria (Dyer's Greenweed)</td>
<td>Woods and meadows Thrace, Macedonia, Athos, the Pindus.</td>
<td></td>
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</tr>
<tr>
<td>Ligustrum vulgare (Privet)</td>
<td>Woods and brushy areas, northern and central Greece, Achaia, Arcadia, Corfu.</td>
<td></td>
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<tr>
<td>Phragmites communis (Reed)</td>
<td>On banks everywhere in Greece.</td>
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<tr>
<td>Petals</td>
<td>B² 3042</td>
<td>312</td>
<td>462</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green parts</td>
<td>B¹ 1743</td>
<td>492</td>
<td>222</td>
<td></td>
<td></td>
<td>112</td>
</tr>
<tr>
<td>Berries, bark</td>
<td>B¹ 1176</td>
<td>344</td>
<td>238</td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>leaves</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Fermented plant</td>
<td>B¹ 763</td>
<td>241</td>
<td>292</td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>Whole plant</td>
<td>B¹ 1746</td>
<td>492</td>
<td></td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>Berries</td>
<td>B² 1860</td>
<td>6</td>
<td>299</td>
<td></td>
<td></td>
<td>54</td>
</tr>
</tbody>
</table>

**DYSES**

| B² 2286           | 116  | 364  |           |           |           |             |
| B² 1860           | 6    | 299  |           |           |           | 54          |

| -                 | -    | -    |           |           |           | 112 ff.    |

**DYSES**

| Green parts       | B¹ 1743 | 492  | 222       |           |           | 112         |
| Flowering shoots  | B¹ 308  | 124  |           |           |           | 54          |
| Berries           | B² 1964 | 34   | 312       |           |           | 54          |
| Flower heads      | B¹ 478  | 173  |           |           |           | 54          |
The colour classifications in the tables are arbitrary, and it will be noticed that the same plant may yield more than one colour, according to the state of its growth, or the intensity of the dye prepared. It must often have been difficult to know whether the fibre, yarn or cloth being dyed would emerge yellow, orange or brown, blue, purple or black, mauve, crimson or purple, and the repetition of a shade must have been well-nigh impossible; the only consolation is that the colours of vegetable dyes are unlikely to clash, having a softness not always found in chemical dyes.

One of the best red dyes, that obtained from the kermes oak (*Quercus coccifera*), must have been at the disposal of the prehistoric Greeks. *Quercus* was present at Early Neolithic Nea Nikomedea in both pollen and charcoal samples; pollen of *quercus coccifera* type was found in a post-glacial zone north-west of Ioannina; a charcoal sample from the Early Minoan site of Fournou Korifi (Myrtos), was identified as *Quercus*, but probably *quercus ilex*; it is recorded in the Early Thessalian period at Argissa; and pollen of a *Quercus* type was present in the second pollen zone from the Osmanaga Lagoon near Pylos.

Oak trees in Greece today are of two kinds, deciduous and evergreen, and the kermes oak is one of the

latter type. No one who has excavated in Greece can fail to be acquainted with it. Its leaves are like miniature holly leaves, rather than deciduous oak leaves, but it has acorns. The nut is inclined to be long, and the cup is covered with rough, projecting, prickly scales, a feature which helps to distinguish it from the holm oak, *Quercus ilex*, in which the scales lie closer to the cup - in other respects they are very similar. As one clears a new site of this tough and prickly menace, it is some consolation to reflect that the people who built the ruins in the earth below probably faced exactly the same problem in their time. Its preferred habitat is the dry places with limestone or siliceous soil in the lower parts of Greece, but no-one could call it a fussy plant - it seems willing to grow, welcome or unwelcome, in most places.

A black dye can be obtained from its bark, but the vermilion dye for which it is known comes not from the tree itself, but from an insect, *Kermococcus vermilio* Planch. (*Coccus ilicis* L.), which lives on the leaves. When the body of the female is extended with unhatched eggs, it has the appearance of a red, berry-like fruit on the tree, and was sometimes mistaken for a berry by ancient writers. The eggs are 'harvested' by being scraped off the leaves with the fingernails, and dried. They produce a dye, the kermes after which the tree is named, when they are crushed and dissolved in water or alcohol. This property was known early in prehistoric Europe, for in France, textiles of the Neolithic period have been found dyed with kermes.

2. The dried eggs are said to have been sold in the market in Chalcis, Euboea, within the last ten years.
Another very important red dye in the ancient world was madder, extracted from the roots of the plant *Rubia tinctorium*. Although this extraction was complicated, the dye was cheaper to produce than kermes, and was used both in ancient Egypt and in the classical world.

Of the yellow dyes the saffron crocus, *Crocus sativus*, probably provides both the best, and the best-known. It is a mauve crocus with very large orange stigmas, which are often taller than the petals themselves. It is these stigmas which provide the dye, about four thousand of them being required to produce an ounce. It is probably a native of the east Mediterranean, and now grows in stony and grassy places all over Greece, including Crete, the Cyclades, and the Dodekanese. There is some evidence for the prehistoric existence of saffron, for this is what the 'saffron-gatherer' in the Minoan fresco is collecting, although, as he is now known to be a blue monkey, this provides no proof of the plant's use as a dye. It is also depicted on sherds, votive robes and tablets.

Even if the plants were specifically cultivated for the purpose, as Evans suggests, the requirement of so many stigmas to produce so small a quantity of dye must have kept it in the luxury class, and yellow dyes were probably obtained from some of the many plants listed in the table of yellow dyes.

2. Mr. Martin Young, Athens, informs me that he has been corresponding with Kew Gardens, and they are of the opinion that *Crocus sativus* did not exist in the ancient world, although a related plant, *C. cartwrightiensis*, may have done. Martin Mobius, Jd.I. Vol. 48, 1933, p. 9 sees *C. cartwrightiensis* as providing the ancestral stock for *C. sativus*.
4. P.M. I, pp. 264 - 265, Fig. 197, Pl. IV; P.M. IV (2), pp. 718, 720 - 721.
5. However the dye is so powerful that a small quantity of it will make up a comparatively large dye-bath.
Weld (*Reseda luteola*) gives a very good, fast dye, and now grows in barren places everywhere in Greece. It is not known to have been used as a dye in the prehistoric world, but this does not mean that it was not.

White goosefoot (*Chenopodium album*), a weed which grows in barren stony places all over Greece today, yields either a yellow or a red dye. It flourished in prehistoric Greece too, being found at Nea Nikomedea, and in the Middle Thessalian period at Argissa.

A dye which has coloured the imagination of every child exposed to first lessons in British history is *Isatis tinctoria*, the famous blue woad. Although, according to legend, the ancient Britons did not apply it primarily to textiles, there is no reason why people in prehistoric Greece should not have done. It now grows in Macedonia, Thessaly, and central Greece, and is thought to be a native of eastern Europe. Its dyeing properties were well-known in both Egypt and Mesopotamia by the fourth century B.C., and it seems reasonable to suppose that they might also have been known in Greece. It was, however, one of the more complicated dyes to prepare. When the plants started to turn yellow they had to be cut, and ground into a paste which

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3. X. Δ. Διπτιολή 1948 op. cit., p. 708, No. 1386
7. X. Δ. Διπτιολή 1948 op. cit., p. 241, No. 763
was stored in heaps. These formed a blackish crust which had to be closed each time it cracked open. After about a fortnight, the heaps were demolished, and the hard crust mixed in thoroughly with the softer interior. This mixture was then formed into balls, which were dried under pressure. In this condition they arrived at the dyer's. He had to crush them to powder, which was moistened and allowed to ferment for nine weeks. After all this, it could be used to give "a good and very permanent blue"; but one cannot help but think that bilberry juice or cornflower petals (see table of blue dyes) would have been quicker. Indigo, the other very well-known blue dye, though used in Egypt as early as the Fifth Dynasty, did not become common there till the Hellenistic period; and Pliny's report that it only began to be imported shortly before he wrote adds to the impression that it did not come into general use until well after the Greek prehistoric period.

A true green dye was, and is, a difficult thing to produce. Of the four plants listed in the table as giving a green dye, tournesole (Chrozophora tinctoria) makes a bluish-green dye, and dyer's greenweed (Genista tinctoria), a distinctly yellowish-green; the latter can, however, be improved by the addition of woad. No information is available about the type of green given by privet or the reed Phragmites communis; as has been seen, the latter was probably available in the period under consideration (page 40 above).

Some record of the colours of clothes worn is

preserved, for the later part of the prehistoric period, in the frescoes found both in Crete and on the Greek mainland, and in none of these does anyone wear a green garment, or even a garment decorated in green. The colours shown in clothing are white, black, beige, yellow, russet, brown, red and blue. A rather pale olive green does appear in the frescoes, but in landscape, herbage or foliage—thus, had the artists wished to portray a green dress, they had the means to do so.

Black would not have been a difficult colour to obtain. A large gall which forms on the leaves of deciduous oaks, known as an oak gall or oak apple, gives a black dye, as do the barks of several common trees shown by pollen analysis and charcoal identification to have existed at least from Early Neolithic times (see dye table, and pages 38, 43 above). Black wool from sheep could also have been used, and brown and grey could also have come from this source. There were several types of brown dye also available, and birch bark, juniper berries and walnuts' husks should have been easy to procure.

The dye for the use of which the best evidence exists does not come from a vegetable source, nor, curiously enough, does it appear in the frescoes, unless it is represented by the plum reds and mauve-tinged pinks that are sometimes seen in them. This is the famous 'Tyrian purple', which legend credits the Phoenicians with inventing, although the earlier Kinoans used it. It is obtained from several

1. For the variety of shades obtainable, see Lillian M. Wilson "The Clothing of the Ancient Romans", 1938, pp. 7-9.
varieties of shellfish, of which the most likely to have existed near the shores of prehistoric Greece are *Murex brandaris* and *Murex trunculus* (Pl. IIa). These creatures have a little vein or cyst which contains a fluid which turns purple when exposed to the air. The larger *Murex brandaris* can be opened close to the vein to extract the liquid, and therefore murex shells which are found on excavations with an opening in this place can be said with certainty to have been used for dyeing, but the smaller *Murex trunculus* were often crushed wholesale. The results from either method were salted down for three days. After this, the mass was soaked in water, and the ensuing mixture was condensed to one sixteenth of the original volume, and all the debris of the crushed shells and rotting bodies of the shellfish was removed. It must have been this stage of the processing which produced the disagreeable odour for which the purple works were noted. The remaining liquid was heated and dyeing commenced. Pliny, who gives all the details of the processing, says that a total of three hundred and eleven pounds of two varieties of shellfish is needed to dye one thousand pounds of fleece, and therefore the dye must have been an expensive one; purple was probably more readily obtained by using bilberries or combining red and blue dyes - but blue dyes themselves were difficult to produce. It is no wonder that purple was so precious a colour in the eyes of the ancient world.

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3. Strabo XVI, 2, 23.
4. Pliny loc. cit. and LXII 133 ff.
The Cretans, always appreciative of the fine things in life, certainly used it. Evans found *Murex trunculus* shells at Knossos, though he does not say whether they occurred in any quantity. Bosanquet offers better evidence - a whole bank of pounded *Murex trunculus* shells with a nest of Kamarae ware pots beside it, on the island of Kaphonisi off the south coast of Crete, and two similar deposits among the ruins of Palaikastro, on the east coast, again associated with Middle Minoan pottery. The Minoan colony on the island of Kythera used purple paint on its Middle Minoan III pottery, and "numerous" murex shells were found there in the excavations at Kastri.

The most circumstantial evidence for the existence of a 'purple factory' was probably that found at Aghios Kosmas near Athens, where, between Late Helladic houses on a reef beyond the main excavation, piles of murex shells were found; these had been broken to enable the dye-bearing cyst to be removed.

The Greeks of today love colour, and under their perennially blue sky and clear light, clothes which would be dazzling in a greyer climate are merely becoming. A theatre crowd at Epidauros, sitting waiting for the light to fade, looks like a terraced flower-bed. Last century marble statues, too often Roman copies, gave the classical Greeks a reputation for clinical purity they little merited. The traces of paint which remain on some statues indicate that in their prime they must have been - not garish - but very gay.

4. G. E. Mylonas "Aghios Kosmas", 1959, p. 57, Fig. 37.
Frescoes leave the same impression. The Greeks have always loved colour - and their clothes in prehistoric times were doubtless as bright as dyes could make them.

**DYEING AND DYEWORNS.**

**Dyeing.**

The ancient Greeks had a profusion of dye sources at their command - yet the reports of dyeworks found on excavations are both few, and tentative. Some consideration of dyeing processes is necessary both to explain why this is so, and to allow vessels and implements which may have been connected with dyeing to be recognised. As raw materials, especially fleeces, are often dyed before being spun, it seems appropriate to discuss the subject here.

It will be apparent from the accounts of Tyrian purple and woad (pages 46 - 47, 49 above) that preparing dye can be a complicated and messy business. Even with simpler dyes, bark, roots and berries have to be crushed, steeped, soaked, perhaps boiled. The requirements therefore are crushers and pounders, containers, and water. The stone pestles and mortars which are found in such numbers on prehistoric sites are suitable for this purpose among others, and any pot of adequate size would serve well enough for the steeping.

1. This is the practice in 'cottage industry' in Greece today, as it gives the best chance of even distribution of the colour, and one often sees a spinner's fingers brilliantly stained by the imperfectly fixed dye. It was also the custom in ancient Egypt (page 27 note 2 above), and in Homer (Odyssey VI, 119 ff.). Flax, however, is often dyed as yarn (information from Mrs. H. Kosmetatos).
If the dye has to be prepared, so do the materials which are to be dyed, and how much preparation they receive depends on the type of dye that is to be used.

There are two main types of dye, direct dyes, and mordanted or vat dyes. A direct dye is one that is soluble, and easily absorbed and retained by the material being dyed. The saffron crocus provides such a dye. Some dyes, however, are not readily assimilated by the fibres, and in such cases a mordant must be used. This is a kind of fixative. The fibre absorbs the mordant, and the mordant in its turn absorbs the dye, bonding it to the material being dyed. (It is possible to combine mordant and dye in one vat, but this is said to give a less satisfactory result). Among the dyes which require a mordant are the reds from the kermes insect and madder (Rubia tinctorum), and the yellows from weld (Reseda luteola), and sumach (Rhus coriaria).

The material to be dyed will absorb either a direct dye or a mordant better if it has first been cleaned, and, in the case of wool, degreased, with a simple alkali. Saponaria officinalis (soapwort), and Salsola kali have already been mentioned in this connection. Both grow in all parts of Greece, the former in damp areas, the latter near the sea shore. Asphodel roots can also be used,

1. Encyclopaedia Britannica (Eleventh Edition), 1910 - 1911, entry under "Dyeing".
5. X. A. Δικτώνα καὶ Καλλιέργεις 1948 op. cit., p. 446, No. 1418.
and stale urine and wood ash are always procurable. As remarked above (page 24), the latter is used in the preparation of linen yarn today. Detergents used for linen by the ancient Egyptians included natron and potash.

This first cleaning or scouring process may have been carried out away from the settlement, on the banks of a convenient river or stream, as still happens today. On one occasion I met a family party of reasonably sophisticated townspeople from Servia in Macedonia, who had come to the banks of the Haliakmon, about twelve kilometres from their home, to scour some filthy fleeces before delivering them to the spinning factory. They had brought their own large iron cauldron, (which was not unlike the bronze tripod found at Gournia in East Crete), and had lit a fire beneath it with wood lying around on the river bank. Their scouring agent was, alas, a proprietary brand of soap powder. After being well-boiled in this, the fleeces were left to rinse themselves by being weighted down with stones in a swiftly-flowing cold spring which entered the river at that point. If these people had lived in ancient Greece, the only archaeological evidence of the scouring process that one could expect to find in their settlement, would be their cauldron. Before large metal vessels became common, thick-walled clay containers like pithoi and tubs may have been used.

If mordanting were necessary before dyeing could take place, this would again require large containers and a reasonable supply of water. Many substances which

would have been obtainable in the ancient world, are suitable mordants. These include alum, many copper and iron salts, earths and organic materials such as tannic acid; tannin may be extracted from oak bark and oak galls, and potassium alum occurs on the island of Melos.

This stage of processing has occasionally left archaeological traces. Tell Beit Mirsim was a Palestinian town which specialised in the manufacture of textiles, and in each of the rooms which contained dye vats there were also jars with slaked lime and potash - substances still used as fixatives in nearby Hebron's dyeworks in this century.

The dyebath itself would again demand a large container or containers, and any vessels of suitable size - large cooking pots, old pithoi, clay tubs, copper cauldrons - would have served. It is therefore possible that dyeing in small quantities - domestic dyeing - would leave no obvious evidence unless traces of colour remained, and if the vessel used were a common, multi-purpose household utensil, it would be well scrubbed out afterwards.

Where material was dyed in 'commercial' quantities,

4. An acquaintance in the Outer Hebrides once demonstrated how yellow dye could be made from kelp, using the saucepan in which she normally boiled milk. Another in Tasmania used the poultry's water bucket. There were no ill effects in either case.
however, there seems to have been a tendency to install fixed dye-vats, and these often constitute the major archaeological evidence for dyeing.

Dye is more permanent if it can be heated, even boiled, while the material is immersed in it, and this is modern practice; but none of the earlier dyeworks found in various countries seems to have had any provision for heating. This suggests that satisfactory results may have been obtained by mere dipping and immersion.

After dyeing, the material would need to have the (possibly precious) dye pressed or wrung from it. It would need to be well-rinsed, and again a swiftly-flowing stream, or the sea itself, would be the most suitable element for the purpose. Finally it must be hung up or laid out in a sunny, windy place to dry.

Dyeworks.

No dyeworks which may be certainly identified as such has been found in prehistoric Greece, but there have been a few tentative claims, the most likely being from Crete.

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1. Dyers' vats found at Pompeii do have a small grate beneath each tub, and these may be the earliest heated vats found - R. J. Forbes "Studies in Ancient Technology IV", 1956, p. 130 ff., Figs. 9, 10. A fixed grate with provision for heating was found at Mycenae (see below) but it cannot be proved to have been used for dyeing.

2. The modern Greek verb for dyeing, βάφω or βάπτω is derived from the ancient Greek βάφεω, which seems sometimes to have had the sense of dipping (Liddell and Scott, Greek-English Lexicon entry under βάφεω). G. Ernest Wright "Biblical Archaeology", 1957, p. 187 ff., gives an account of dyeing by successive immersion in two dye baths in Hebron, Palestine, in the 1930s, in which no mention of heating is made.

3. When buying local cloth in the Pacific islands, one is told to immerse it in the sea for some hours. This removes the last of any excess dye, and renders the cloth extremely colourfast.
Ancient dyeworks seem to be comparatively rare in all countries, but one of the best authenticated was found in the seventh century B.C. phase of Tell Beit Mirsim (Debir), the Palestinian site already mentioned. On the analogy of this and another Palestinian site, the Greek scholar Chrysoula Kardara has identified as a dyeworks the installations on the top of the little hill at Isthmia known as the Rachi. These claims seem valid, and are worth considering in detail to serve as a basis for comparison when discussing the Minoan and other possible prehistoric examples.

No less than six dye plants were found at Tell Beit Mirsim, and the site was not completely excavated. Generally speaking, the equipment in each plant consisted of two round, flat-topped tubs, each hollowed out of a single block of stone (Pl. 11b). Each tub was adjoined by a shallow, square basin of "cement" (for scouring? mordanting? rinsing?) and the jars containing the lime were in nearby corners of the room. In the same room as the vats, the excavator, Albright, usually found a number of large, doughnut-shaped stones, fifteen or sixteen inches in diameter, lying in a single line. He interpreted them, with reservations, as weights for a dye press, to press the excess dye out of material after dyeing. Other authorities were quick to point out that oil-presses were constructed in this manner.

1. 'Palestinian' is used only in an archaeological sense. Both sites are in Israel.
4. For illustrations of oil presses worked on this principle, see: R. A. S. MacAlister "The Excavation of Gezer" Vol. 11, 1912, pp. 51, 63, 64, Figs. 257, 258; Elihu Grant "Ain Shems Excavations (Palestine)", 1931, p. 27.
but why have an oil press in a dye works? If these stones were press weights, the hypothetical press could have been for crushing raw dyestuff as well as extracting excess dye. Were it not for their very considerable size, the fact that they lay in a line would suggest that they might have been loomweights; their shape is the same as that of the much smaller clay loomweights which were found in "vast quantities" throughout the site. Albright was of the opinion that there must have been a loom in nearly every house. The function of the pierced stones must remain an unknown quantity, but it is worth noting that they are associated with dyeworks.

The evidence from this site then, is 1) vats, 2) plastered tanks, 3) slaked lime and potash in jars, 4) pierced stones, and 5) vast quantities of loomweights. Note that no mention is made of provision for heating the vats.

Turning now to the Hellenistic dyeworks at Isthmia, Miss Kardara, who excavated the area, found four sets of small cisterns and tanks, cut into the bedrock and well-cemented. Each dye-plant consisted of a square tank, a cemented platform on a slightly lower level, two basins with their rims on a level with this platform, and finally another small, rectangular tank on a slightly lower level than the basins (Pl. IIIa, b). There were ashes among the fill of some of the rectangular tanks. Large jars sometimes stood near them. An "amazing quantity of loom-weights" was found amongst these remains. Also present

1. The dye vats were initially recognised as such not by the excavator, but by his Arab workmen from Hebron, a town where dyeing is still being carried out today.
were many large pieces of terracotta roof tile, jugs, amphorae, spouted bowls, cooking pots, millstones and grinders, an extraordinary, large, tub-like vessel, with a funnel-shaped attachment above one end, possibly for extracting excess dye, and a number of doughnut-shaped, pierced stones, which were, however, much smaller than the Tell Beit Mirsim ones. The hilltop position of the Isthmia dyeworks is explained as being necessary for the drying of the dyed material, and the broken roof tiles as weights for the drying cloth. There is a stream just below the Rachi, to provide the water supply so essential for dyeing.

Miss Kardara adds to her arguments a comparison with another, unpublished, hellenistic dyeworks, again in Israel. This is Tell Kor, on the coast near the port of Ashdod. These dyeworks, which appear to be very similar to the Rachi ones, included a deep well containing thousands of murex shells.

How would the Rachi dye plants have worked? The highest rectangular tank may have been for mordanting (it was in the rectangular tanks that débris of ashes was found). The two round-bottomed basins were presumably the two dye baths which seem to be the optimum. Excess dye could have been pressed or wrung from the material on the adjacent platforms, and the final, downhill rectangular tank may have been for an initial rinsing. Once again there was no provision for heating; yet as these dyeworks were presumably

2. Each of the Tell Beit Mirsim dye plants had two vats (see Pl. 11b); and two vats were used at Hebron in the 1930s - G. Ernest Wright "Biblical Archaeology", 1957, p. 187 ff.
supplying the luxury-loving inhabitants and visitors of nearby Corinth, the results must have been highly satisfactory.

The Rachi evidence, consisting of 1) "vats" (the plastered basins), 2) plastered tanks, 3) "debris of ashes", 4) pierced stones, purpose unknown, and 5) "amazing quantities of loomweights", is strikingly similar to the evidence from Tell Beit Mirsim. Also worth noting are the millstones and grinders, the many household vessels of useful shapes, and the hilltop position for drying the dyed material.

Certain analogies with the Isthmia dyeworks led to the initial suggestion that the summit area of the Early Minoan settlement at Kyrtos (Fournou Korifi) on the south coast of Crete, might have been connected with dyeing. The site was again situated on a sunny, windy hill, and again the curious doughnut-shaped stones were found, although not concentrated in any one area. Quernstones, pounders, rubbers and grinders existed in large numbers, and could have been used in the preparation of organic dyestuffs, as well as the grinding of grain. Spindle whorls, and loomweights in reasonable numbers were found at the site, so textiles were certainly made there. Finally, there were two large clay tubs with low-set spouts, one of which was set on three large, flat stones, in the room next to the one in which most of the loomweights were found, while the

2. Peter Warren "Kyrtos", 1972, pp. 52 - 55, Fig. 21. The juxtaposition would not be relevant if the loomweights fell from burning rooms above.
other was set on an earthen platform with its spout above a hole connected with a channel which led off downhill (Fig. 2). Paving at the back of this tub provided a possible work space, and a burnt patch beside the hole suggested that something had been heated nearby. The whole area contained a "hard, white, clayey earth", a description which suggests fuller's earth, and fulling might also have been carried out here.

The Myrtos spouted tubs are unique only in their early date. Similar spouted tubs, usually in Late Minoan contexts, have been found at Gournia, Vathypetro (Fig. 2), Kato Zakro, possibly Epano Zakro, and Ialysos on Rhodes.

Most of them were found in situ, and usually formed part of an 'industrial installation'. In the two simplest cases, Myrtos and Gournia, they were respectively set above a hole with a connecting channel, and a simple channel. At Vathypetro the spouted tub was set on a

2. Peter Warren, L.E.N. 17th, 1968, p. 26. (Fuller's earth is a natural white earth, rather like piper clay, which has a capacity for absorbing grease and stains. Fulling is a finishing treatment for woven cloth, especially woollen cloth, which uses this earth or a similar substance - see R. J. Forbes "Studies in Ancient Technology IV", 1956, p. 81 ff.).
3. H. Boyd Hawes "Gournia", 1903, Pl. 1, No. 14, and sketch on p. 27.
4. S. Marinatos, Praktika 1952, p. 596, Fig. 6.
5. D. G. Hogarth, B.S.A. VII, 1900-1901, pp. 130, 140 - 141, House I, Room XVI, Pl. V, 2, and Fig. c, House A, Room XIV, and House E; N. Platon, Praktika 1961, Pl. 174b; Praktika 1962, pp. 148 - 149, and plan opposite p. 152; Praktika 1963, p. 164, Pl. 142, House B, Room 8, House χ. 6. Ergon 1965, pp. 130, 139, Fig. 172; Ergon 1964, p. 144.
7. G. Konacos, Ολοκληρωμένα Εφημερίδες Μελετών Χρονικά, 1941, p. 198, Pl. XXII.1c.
platform above another slightly larger tub without a spout. Beside the spouted tub was a pithos, and beside the spoutless tub, on the floor, a curious channel connecting two very shallow basins, one circular and one semi-circular (Fig. 2). No less than five spouted tubs, set on platforms above clay basins or pithoi, have been found at Kato Zakro, housed in little complexes which often included an extra pithos, a plastered cistern, a flagged floor, or a clay drain pipe (page 60 note 5 above - Fig. 3).

The installation in the 'farm house' at Epano Zakro, about six kilometres up the hill from the main site, was even more complex. It comprised two tubs set in a platform above a lower basin, which in turn was set above a plastered tank, which had two sunken tubs in one corner, the rims of which were flush with the tank’s floor. Although the two upper tubs do not appear to be spouted in the published illustration, this may be because they are embedded to their rims in their platform; a connection between them and the tub below is suggested on a plan.

All these installations resemble the Rachi dye-works in being a series of containers, sometimes interconnected, arranged in a descending order of height.

They have been variously interpreted by their excavators. Harriet Boyd Hawes thought the Gournia tub might be an olive oil separator, and it is indeed similar to today’s equipment in rural Greece. The low-set spout

1. The circular basin, although it appears on site plans, was not visible when I visited the site, and hence does not appear in the sketch in Fig. 2.
2. Ergon 1965, Fig. 169 on p. 137.
3. Ergon 1965, Fig. 172 on p. 139.
4. Ergon 1964, Fig. 168 on p. 144.
5. In this she followed R. C. Bosanquet, B.S.A. VIII, 1901-1902, pp. 264-268 and Fig. 31.
6. An olive oil separator I saw at Diakopto in 1970 was made of stainless steel, but operated on the same principles.
would be plugged, and a mass of crushed olives drenched in hot water in the basin. The olive oil would separate and rise to the top. The bung could then be removed, the water and debris run off, and a container placed below the spout when the oil started to come through.

Hogarth suggested that the installation in his House 1's Room XVI was a bath or a wine-press, and added that native opinion inclined to the latter. Again these little installations are similar to modern rural equipment - the only objection is that the size of the spouted tubs would not permit more than one person at a time to tread the grapes. The Epano Zakro complex is referred to as a "double press".

The room in which the spouted tub was found in the upland villa at Vathypetro (Room 13) also contained a great many globular loomweights, and this led Professor Marinatos to consider whether the room might not be a weavers' workshop, in which case he suggested that the shallow stone basins in the floor and their connecting drain could have been used for colouring or washing thread. Elsewhere in the text, however, he compared his installation with wine presses used in modern Crete. As loomweights were found in the spouted tub, as well as scattered round the room, it is possible they fell from a burning upper storey. (The guard at the site pointed out the marks of two burnt wooden uprights in the south-west of the room as evidence for the position of a loom, but it does not appear to be mentioned in the preliminary reports).

1. S. Marinatos, Praktika 1951, p. 269.
Peter Warren, in his final publication of the spouted tubs from Myrtos, takes the oil separator and wine-press theories into consideration, but also adheres to his original idea that they might have been used for the washing or fulling or wool or cloth. This theory is quite impressively supported by the fact that chromatography analysis of the clay of the tub near the room with the loomweights showed that it had been impregnated with animal rather than vegetable fats.

One possibility which should not be overlooked is that these little installations may have been multipurpose household equipment. They are suitable for wine presses; wine pressing takes place in August. They are suitable for olive oil separators; olive oil is separated in December. They are suitable for washing fleeces or preparing infusions of dye, or mordanting; with judicious plugging and unplugging of the spout, they would be good two-stage dye baths. It is impossible to confine them with any certainty to any one of these purposes.

Kato Zekro, the site which produced so many spouted tub installations, also has a more confident claim to a dyeworks. Professor Platon, the excavator, describes it as follows:

"The West Block had been extended to accommodate workshops. One of these (XX on Plan) was a dyehouse where the liquid colours were produced in rows of tubs. Kato

Zakro appears to have specialized in murex fishing and dyeing. On a small island nearby, a large number of snail shells were found..., with manufactured violet dye." If the island referred to is Kouphonisi, it is not very close, but in view of the odiferous nature of the work, it is quite possible that the initial extraction of the dye might have taken place out of the olfactory range of the palace.

In a more detailed account, Platon mentions that the nine rectangular troughs had had many successive coats of plaster. The area between them was also plastered, and, from the illustration (Pl. IIIc; Fig. 3) this floor appears to consist of three plastered areas on different levels, which might once have been larger plastered tanks. In the area immediately adjoining was found other equipment - the remains of basins and other pots, one of curious shape, and a stone "level" or weight. It is attractive, but not conclusive evidence. If one accepts that dyeing may be accomplished by dipping or immersion only, this series of troughs and tanks is certainly suitable not only for the dye bath or baths, but for scouring and separate mordanting beforehand, and rinsing afterwards. The successive coats of plaster do seem to indicate that the tubs were meant to hold liquid, and the block in which they were found seems to have been an addition to the main plan of the palace, being self-contained, with its own outside entrance, and its own lavatory (?). Its interpretation as an industrial annexe is very reasonable - but it cannot be unquestionably proved to have been used for dyeing.

2. N. Platon, Praktika 1964, p. 146; Pl. 144~.
If, however, the structure that Professor Platon found was a dyeworks, Hogarth had just such another in his House I at the same site. Just to the right of the entrance to Room V, the largest and most central room of the house, was "a narrow chamber supplied with five plastered kitchen troughs, raised on a step seven inches high (Plate V 4). The surface water from chamber V was carried off by means of an open channel of baked red clay, one inch wide by one inch deep, over the floor of the adjoining Room X, and through a hole in the West Cyclopean wall" - in other words the little drain ran conveniently past the foot of the tubs (Fig. 3).

It has already been noted that in Room XVI of House I there was a spouted tub complex. Room XVI itself seems to have been a tank or cistern, as its narrow (1' 4") doorway did not go right down to the floor, and both the floor and the walls were well-plastered; Hogarth estimated it could be filled with water or other fluid to a depth of 1' 2". In the south-west corner of the room was a slight recess, where a large clay receptacle was sunk to its rim in the floor.

House I had many curious features. Room IV, just to the back (south) of the plastered troughs, had plastered walls and a paved floor, was sunk below normal floor level, and from the plan, looks as though it was divided into three compartments; Room VIII was stone paved, and 5' 3" below the general floor level; Room VII had a slab tank set in a corner; Room XIV had seven amphorae ranged round the walls.

and about twenty pierced stones and several pierced clay weights in the centre, among a mass of ashes and burnt bones. More loomweights were found in Room XIII. (Fig. 3)

House I therefore possessed at least two looms, and a number of troughs, tanks, basins, sunken chambers and cisterns quite excessive in a private house. It does not seem unreasonable to suppose some kind of industrial activity occurred here, and in view of the presence of loomweights, and the pierced stones which appear to have some connection with dyeworks, it is possible that the activity may have been dyeing.

It would be surprising if dyeing had not been carried out somewhere in the vicinity of Kato Zakro, for textile manufacture, on a scale large even for Crete, was certainly taking place there. Hogarth found "vast numbers" of loomweights there in 1901, and Platon used exactly the same words in 1963.

It is strange that the richest and most beautiful of all the Minoan sites after Knossos itself should be situated in one of the poorest parts of a poor island. It is cut off from the rest of Crete by a long, narrow gorge and steep hillsides carrying only prickly scrub. The agricultural land immediately around the site is fertile, but its area is very limited. The bay provides an anchorage for a few fishing boats, and is one of the best harbours on the east coast of Crete - but that is very faint praise.

1. D. G. Hogarth, B.S.A. VII, 1900-1901 pp. 130, 140 - 141
2. D. G. Hogarth 1900-1901 op. cit., p. 128, also pp. 139, 140, 141, 142 etc.
To achieve wealth in such unpromising circumstances, the people of Kato Zakro must have been able to produce some highly desirable commodity, and textiles is an obvious possibility. If the installations identified as dyeworks at Zakro are not dyeworks, then none have been found.

One or two sites beyond Crete have interesting arrangements of tanks and basins for which no special claim has been made, and about which nothing can be proved, but which would seem to have been suitable for use in dyeing.

At Phylakopi on Melos, in the northwest of the site (F 2 on Atkinson's plan) was a group of rooms apparently used for industrial purposes. Numbers of shallow, spouted bowls were found, and other vessels possibly used for smelting bronze. Floors were plastered, and drains existed. A large, internally painted bath or tub was found in the area, and "on the same level occurred two stone sinks or washing troughs" in situ. The one illustrated in the publication is set into a low wall or platform, and has a shallow spout. The installation belongs to the Third City. Other tanks were found elsewhere, one filled with plain cups, loomweights and stone pestles, and another near scarlet colouring matter stored in vases.

In a Late Helladic II context at Aghia Irini on

1. T. D. Atkinson et al. "Excavations at Phylakopi", 1904, pp. 13 - 14, Fig. 6; and 'a' on square F 2 on plan of Third City.
2. T. D. Atkinson et al. 1904 op. cit., pp. 17, 53, Figs. 44, 45, and Room 4 'e' on square G 3 of Third City plan.
3. T. D. Atkinson et al. 1904 op. cit., pp. 18, 79. The colouring matter was identified as oxidized iron and silica, and, as such, is likely to have been colouring matter for frescoes rather than for dye. The colouring matter was from the Second City, the sink from the Third City, but the sink had replaced earlier, similar troughs.
Kea, colouring matter, "white calcareous matter", crushed murex shells and pots containing plaster residue were found, but the suggestion that it was a plaster workers' quarter may be quite correct.

The 'Palace of Nestor' at Male Knglianos in Messenia has some interesting remains of installations in its eastern quarter, which seems to have been a workshop area. Room 102 on the plan, and the area immediately to the northwest of it, appear to have been a triple cistern, with stepped floors, of which Room 102 itself is the lowest. These did not appear to have any outlet. A clay larnax was sunk to its rim in a fill of greenish earth in Room 103. Two rooms in the north-Eastern Building, Rooms 97 and 98, had contained red and yellow substances; these looked like coloured earth and ground up stone, and it is more likely that they were pigments for frescoes than dyes. Water was supplied to the area by an aqueduct, and a stone gutter running from this down passage 91 had a "heavy calcareous accretion" in it. Some of the site's loom weights came from this area.

At Mycenae, the 'House of the Oil Merchant', which contained a number of tablets dealing with wool, had a room with a number of pithoi set into a clay bench. One of these had provision for heating.

8. A. J. B. Wace, B.S.A. XLVIII, 1953, p. 12, Fig. 2, Room 1.
These are only the most tentative of suggestions, and little weight can be attached to them in a situation in which not even the much more promising Kato Zakro installations can be identified with absolute certainty as a dyeworks.

SPINNING AND SPINDLE WHORLS.

Spinning.

It has already been shown that spinning is one of the most ancient of the textile arts, practised in palaeolithic times, achieving competence in the mesolithic era, and rivalling modern standards at the beginning of the Neolithic Age (pages 6 - 9 above).

Spinning is the art of pulling a few fibres from a mass, and twisting them into a continuous thread. This is true of every kind of spinning, from hand-spinning without tools, to Arkwright's Spinning Jenny and its successors.

Hand-spinning without tools, still sometimes used, may have been the first form of spinning. A few fibres are pulled from a heap or mass, and rolled between the palms, between palm and thigh, palm and cheek, or any other part of the anatomy that seems convenient. When these are sufficiently twisted, a few more fibres are pulled out, and, without breaking off the prepared section, twisted - and so on, until a long, continuous thread is formed.

This eventually has to be rolled up, or wound up, and for the latter a stick is useful. This may have led to the development of the spindle.

The spindle is a slender, tapered rod, usually of wood, sometimes of bone or ivory, bronze or other metal; it may have a groove or hook at the top round which the thread is fastened while spinning is in progress.

It is possible to spin with the spindle alone, but if a small, wheel-like object, a spindle whorl, is added, it acts like a fly-wheel, giving the spindle added momentum, and keeping it revolving much longer.

One other tool sometimes associated with spindle spinning is the distaff or rock. This is a long forked stick on which the mass of unspun fibre may be bound. The end of it is then tucked into a belt, or held under the left arm or in the left hand (Pls. IV, V). It is not necessary to have one, however, as the fibre may be wound round the left wrist, hung over the left shoulder, or again, held under the left arm.

Spinning with a spindle and whorl, already known in paleolithic Europe (page 6 above), was apparently so satisfactory a method that no change was to take place there until the introduction of the spinning wheel, probably in the late thirteenth century A.D. in spite of the invention of first the wheel, then machine spinning, many people are still spinning in the old way today.

A number of different methods of spinning with a

2. The wheel seems to have been invented in India for cotton spinning, although there is disagreement about the date. It was used there, and in China, earlier than in Europe - R. J. Forbes "Studies in Ancient Technology IV", 1956, p. 156; R. Patterson "Spinning and Weaving" in S.M.N. Vol. 11, 1956, pp. 202 - 203.
spindle and whorl were in use in the ancient world, and have continued into modern times.

a). Drop spindle.

This is the fastest and most efficient of all methods of hand spinning, and produces a fine, even thread. It is the more popular of the two methods in use in modern Greece and is also common in Israel and Jordan. It is the method invariably depicted on Greek vases, some of which go back to the sixth century B.C. (Pl. IVa). It may be carried out either sitting (Pl. IVb), standing (Pl. IVc), or walking.

In modern Greece, the unspun fibre is always bound upon a distaff, and again the vase paintings confirm that this was also the practice in classical Greece. The fibres may be either in a teased mass, or in a rove, a long, comparatively thin roll of fibres already drawn out parallel to each other, but not twisted. The latter is preferable when a smooth, fine thread is desired.

To begin the work, a few fibres are pulled out and twisted by hand; more are added until a thread about 30 cms. long is produced. The end of this is then tied

2. I should like to thank Miss Eustathia Kasselouri, of Votjino, Epirus, for her patience in teaching me to spin by both this and the other Greek method, e). below. In travels all over Greece and the islands, I have not seen any method other than these two used.
4. H. J. Forbes "Studies in Ancient Technology IV", 1956, pp. 162 - 164, Figs. 15, 16; Fig. 2B on p. 19.
5. The prepared rove you can buy in Greek woolshops is 3 - 4 cms. thick.
round the thickest part of the spindle, wound up a little, then caught at the top by being passed under a little hook or round a spiral groove, or simply being twisted over the top of the spindle in a single hitch. The spindle whorl is added, always, in Greece, to the bottom of the spindle with the widest surface towards the spinner, and spinning proper can begin.

The right hand twirls the spindle and lets it drop, upon which it continues twirling in mid-air for some little time. The left hand, meanwhile, has the more difficult task of continuously pulling fibres from the mass, keeping them roughly parallel to each other, and even in quantity. A poor spinner can use the right hand to assist the left in this delicate manipulation once the spindle has dropped, but a good spinner keeps the right hand hovering near the spindle, twirling it almost continuously. (Pl. lVb,c).

When so much thread has been spun that the spindle is in danger of trailing on the ground, work has to stop while the thread is wound up (Pl. Vc, d). This happens every other minute, and is the worst part of spinning. It was probably the major reason why the spinning wheel was invented, as the one great advantage it has over hand-spinning is that it winds up the thread while spinning is in progress.

When the spindle has a good quantity of thread wound on it, this of itself provides sufficient momentum

1. Both in vase paintings, p. 71 Note 4 above, and in modern Greece. In Palestine, however, it is at the top - Shelagh Weir "Spinning and Weaving in Palestine", 1970, Pls. 5, 6.
and the whorl may be removed (Pl. Va, c).

b). Thigh Spinning, Standing.

This method is very closely related to the previous one, but the spindle is made to rotate by being rolled along the thigh, instead of being twirled between the fingers. It drops and spins in mid-air in the same way. This method gives a strong and fast twist to the spindle, and results in a hard-spun yarn. It is illustrated in wall paintings in Egyptian tombs from the Middle Kingdom (Figs. 4a, e, f, 5b); some of the spinners were apparently capable of keeping two spindles going at the one time, rolling them alternately (Fig. 4d, e, f), but they were aided by being able to work from very fine roves which were ready prepared for them (Fig. 5a), and stored in baskets or spinning bowls (Figs. 4b, c, d, e, f, 5b, c), which had internal loop handles to keep the roves in position (see below, page 273 ff.). This method, albeit with a single spindle, is still practised in Egypt and the Sudan, Palestine and the Turkish parts of Cyprus, but is not seen in modern Greece.

c). Thigh Spinning, Seated or Kneeling.

Fibres are drawn out from the mass, and then twisted by the spindle's being rolled along the thigh. The advantage of this method is that, as it places little strain

2. For a detailed discussion, see Grace M. Crowfoot 1931 op. cit., pp. 27 - 29.
5. I should like to thank Mrs. H. W. Catling for this information.
upon the thread, short staple and poor quality fibres may be used; its disadvantages are that the drawing out and twisting of the fibres cannot take place simultaneously, as it can in the two methods already discussed, so that spinning is slower, and the thread is not likely to be as strong as that which has had to support the weight of a spindle and whorl suspended from it. This method is used in Palestine (Pl. IVd) and the Sudan, and was also known in ancient Egypt (Fig. 4b). I have never seen it is Greece.

d). Grasped Spindle.

A prepared rove is a necessity for this method; it is passed over a support, such as a forked stick, and the spindle is grasped and twirled with both hands. This places little strain upon the thread, but the result is coarse and uneven. The method is better suited to the doubling or plying of pre-spun threads than to the initial spinning. It is seldom used today, but was known in ancient Egypt (Fig. 4c).

e). Horizontal Spindle.

This is the other method used in Greece today (Pl. Va, b). The whorl is placed on the lower end of the spindle, and the thread caught at the top, as in drop-spinning. The spindle is then held horizontally in the right palm, whorl

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2. Grace M. Crowfoot 1931 loc. cit.
5. Grace M. Crowfoot 1931 op. cit., p. 18.
outwards and the top of the spindle towards the spinner, and rotated by a complex combination of movements of the first two fingers, the thumb, the palm of the hand, and a little flick of the wrist, very difficult to master. Like seated thigh-spinning, this method puts little strain upon the thread, and is therefore suitable for short-stapled fibre; it is convenient in situations in which one does not wish the spindle to go free, as when riding (Pl. Va). The method is widely used today, in Egypt, the Sudan and Palestine, as well as in Greece. Although most Greek spinners with whom I have spoken have been familiar with this method as well, it does not seem to be as popular as the drop spindle method; it is, however, often used for doubling. There does not seem to be any positive evidence for its use in the ancient world.

Any of the above spinning methods might have been used in prehistoric Greece, but, although conclusive proof is impossible, it is likely that the drop spindle method was then, as now, the one in favour.

The fierce conservatism of spinning traditions has been demonstrated by Grace M. Crowfoot. Spinners in Egypt and the Sudan in this century resembled the Egyptian spinners from Middle Kingdom to Roman times in mounting their whorls at the top of the spindle, in rolling the shaft of the spindle along the thigh, and in spinning without a distaff.

No prehistoric representations of spinning have as

2. Grace M. Crowfoot 1931 op. cit., pp. 30, 31, 35, 36. The one instance in which the whorls were mounted at the bottom of the spindle was thought very odd - p. 34.
yet been found in Greece, but classical vase paintings (page 71, note 4 above) coincide with modern practice in showing the whorl mounted at the base of the spindle, and the use of a distaff, the latter also being attested in literature from Homer onwards.

The position in which the whorl is mounted may in itself be an indication of the spinning method in use. If the spindle is to be rolled along the thigh, it is preferable to have the whorl mounted at the top, out of the way of the hand, which rolls the shaft of the spindle. In drop spinning, however, in which the fingers twirl the top of the spindle, it is more convenient to have the whorl at the bottom. Therefore the low-mounted whorls seen in vase paintings are likely to mean that the drop spindle method was being used.

There is another indication besides that of tradition that some prehistoric Greek whorls at least were used at the base of the spindle. Whether the whorl is placed above or below, its greatest diameter should face towards the centre of the spindle, which spins better so. This means that if a whorl is at the bottom of the spindle, its widest surface will be uppermost. Modern Greek whorls are often carved, and the most elaborate decoration is on the larger, upper surface - where the spinner can see it. Although the majority of Greek prehistoric whorls are plain, there are some which are decorated (Figs. 59c, i, j, k, 61a, b, c, 67i etc.), and again the more elaborate patterns (some-

1. Homer, Odyssey IV, 119 ff.; Herodotus IV, 162; Aristophanes, Frogs, 1347; Euripides, Orestes, 1431-1436 etc.
times the only patterns) are on the wider surface - the
surface that faced the spinner.

The horizontal spindle method may have been used
in ancient, as in modern Greece. The fact that it does not
appear in any representations does not preclude its use.
Two ivory spindles from a late Mycenaean cemetery which have
their whorls mounted in the upper position (Fig. 68), like
those in the Egyptian tomb paintings, may indicate a know-
ledge of the thigh-spinning methods, although the possibility
that they are imports decreases the value of their evidence
in this respect (page 439 ff. below).

The direction in which yarn is spun is of some
importance. Yarn that is spun in a clockwise direction is
said to be Z-spun, because the slant of the twist in the yarn
is the same as that in the central portion of the letter Z.
This is true whichever end the yarn is viewed from. In the
same way, yarn spun in an anti-clockwise direction acquires
a twist which slopes in the same direction as the central
portion of the letter S (Fig. 6).

It has already been pointed out that flax fibre,
when drying, rotates in an S direction, and is therefore
best spun in that direction. It is possible to Z-spin flax,
but the resulting thread will be weak and likely to unravel. 2
Although there are some exceptions, it is generally true
that early linen textiles were S-spun.

2. The earliest Egyptian textiles from the Fayum and Badari
were S-plied, but where any twist was visible, the original
threads seemed to be lightly Z-spun - Grace M. Crowfoot
3. G. M. Crowfoot "The Linen Textiles", Chap. III in D. Barth-
elemly, O. P. and J. T. Milik "Discoveries in the Judean
Desert I - Qumran Cave I", 1955, p. 19; R. J. Forbes 1956
op. cit., pp. 150 - 151.
Wool may be equally well spun in either direction, but in practice usually seems to be Z-spun. This is true of both Greece and Palestine today, and, curiously enough, the tradition is often continued in factory-spun knitting wool.

Thus if textiles are found on an excavation, the twist in the spinning of the thread may give a clue to the raw material used. If it is S-spun, it may be either wool or flax; but if it is Z-spun, flax is unlikely.

If a single thread is not considered strong enough for the purpose for which it is required, it can be doubled or plied. This means that two spun threads are twisted together to form one. A heavier whorl can be used for this, and the spindle should be rotated in the opposite direction from the one in which the original yarn was spun - thus S-spun thread should be Z-plied, Z-spun thread should be S-plied (Fig. 6). Unless this is done, the resulting plied thread is likely to untwist. More than two threads may be twisted or plied together. Three- and four-ply yarns are common today, and there is an ancient reference to a seventy-two-ply thread, but the principles involved remain the same.

Materials may have had some effect on the methods of spinning developed in different countries. In thigh spinning, particularly when standing, the more natural direction to roll the spindle is with the force of gravity, from hip to knee, and (in right-handed spinners, who are the


2. Cotton is best Z-spun; silk has no bias.

natural majority) this will produce the S twist suitable for flax. When using the drop spindle method, however, it is more natural for a spinner (again, if right-handed) to twirl the spindle clockwise, which gives the Z twist so commonly seen in wool. Although this argument is not conclusive, because there are exceptions to these rules, it may be no accident that the ancient Egyptians, producers of fine linen from earliest times, used spinning methods likely to produce an S twist, while the Greeks of classical, and probably also prehistoric Greece used one that is more likely to give the Z twist which is unsuitable for flax, but so often found in wool.

Spindle Whorls.

The three tools which may be used when hand-spinning are the distaff, the spindle, and the whorl, and of these three the only one the archaeologist is likely to find, is the whorl.

As distaffs have been used in Greece from Homeric times, it is likely that they existed in the prehistoric period also, but as they would have been made of wood, none could be expected to survive.

Spindles have suffered the same fate for the same

1. in Egypt and the Sudan today, the ancient methods are being used for wool and cotton rather than flax - Grace K. Crowfoot "Methods of Hand Spinning in Egypt and the Sudan", 1931, pp. 31, 38, 43. There they roll the spindle from hip to knee, but in Palestine, again spinning wool, it is rolled in the opposite direction - Grace K. Crowfoot 1931 op. cit., p. 19, Note 1; Grace K. Crowfoot, P.E.G., 1945, p. 129, Note 3.
Some tubes of gold leaf from Shaft Grave III at Mycenae may once have covered wooden spindles, and a few of bone or ivory survive (Figs. 54a, 68; pages 272 ff., 439 ff. below). Spindle whorls, however, usually of clay, less often of other materials such as bone, ivory or stone, have endured in their dozens, hundreds, even thousands.

They are not always easy to identify with certainty, because almost any object that is approximately circular and more or less centrally pierced can be used as a whorl. In Greece today one sees many curious objects being used for spinning besides the orthodox wooden whorls; cotton reels sawn in half, spring onions, new potatoes, even a corn cob chewed into a convenient shape. When looking at an object, it is often impossible to decide whether it is, for instance, a small whorl or a large bead, because a large bead makes a perfectly good spindle whorl; judgment must be based on the circumstances of the find.

Certain fixed limits can, however, be outlined. Two factors influence the capacity of a whorl to act as a fly-wheel to the spindle: its weight, and its diameter. A narrow sheath of plasticene folded round the spindle in lieu of a whorl, will aid its rotation if it weighs 20 grams or upwards. A circle cut out of stout card, weighing as little as 5 grams is effective if it has a diameter of more than 10 cms.; but generally speaking, an object will not be effective as a whorl unless it has a weight of 10 grams or more, and a diameter of 2 cms. at the very least. At the other

2. Sometimes not even circular - Shelagh Weir "Spinning and Weaving in Palestine", 1970, Pls. 1 - 4; D. Bercliu "Contributii La Problemele Neoliticului in Rominia in Lumina Noilor Cercetari", -, Fig. 156.
end of the scale, whorls weighing more than 90 grams are tiring to work with, and are inclined to break the thread easily, although it is possible to spin with whorls weighing as much as 160 grams. Whorls with diameters of more than 7 - 8 cms. are clumsy. The wooden whorls used in Greece today, designed for wool spinning, have diameters of 3.5 - 7 cms. and weights of 11 - 40 grams.

The size and weight of whorls found on excavations may help to give an indication of the type of raw material they were used to spin. Cotton, with its very short staple, can only be spun with a very light spindle and whorl. The long, strong, but not particularly cohesive fibres of flax require a relatively heavy whorl, and it is no accident that those found in Egypt are often of stone. Wool needs a whorl of medium weight, heavy enough to control the elastic nature of the fibres, but not so heavy as to break them. The whorls found in all periods of Greek prehistory, except the Early Bronze Age, are of moderate size and weight. Their weight range is similar to that of modern Greek wooden whorls, but as the majority are made of terracotta, their diameters are inclined to be smaller.

Performance.

'Hand-spun yarn' conjures up an image of something

1. Four in my possession have the following dimensions:

<table>
<thead>
<tr>
<th>Diameter:</th>
<th>Weight:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 4.7 cms.</td>
<td>11 grams</td>
</tr>
<tr>
<td>2) 5.3 cms.</td>
<td>23 grams</td>
</tr>
<tr>
<td>3) 5.6 cms.</td>
<td>33 grams</td>
</tr>
<tr>
<td>4) 0.6 cms.</td>
<td>40 grams</td>
</tr>
</tbody>
</table>


4. R. J. Forbes 1956 op. cit., p. 44.
rather lumpy and homely, but this need not be the case. Thread spun with a spindle and whorl can be as even and almost as fine as anything that can be produced either by the wheel or by a factory, especially if a good rove has been prepared beforehand. It is in fact more difficult for a good spinner to spin an irregular thread than an even one. The textiles from Çatal Hüyük, and all the fine linen of Egypt had to be produced by this 'primitive' method - no other was available - yet a fragment of linen found in a First Dynasty tomb at Abydos was so fine that it contained 160 x 120 threads per square inch.

Spinning with a spindle and whorl is also surprisingly productive. Although the turnover from a spinning wheel is naturally greater, a good hand-spinner is said to be able to produce 60 - 110 metres of yarn per hour.

It is a pleasant occupation. It requires a sufficient degree of skill to make it interesting, but once this has been acquired, it does not demand so much of one's attention as to prevent one from thinking of other things. It can be a social art, for it does not preclude company or conversation, and, unlike wheel-spinning, a mobile one - it can be pursued while riding a donkey or following sheep. It is still quite a popular pastime in rural Greece, and girls still look forward to learning it when they turn fourteen, which, it seems, is the proper age for it. Everyone appears

1. A woollen thread as fine as a size 20 sewing thread can be produced with a light wooden spindle and whorl.
3. Without a distaff and with the wool caught at the top of the spindle in a single hitch, I can produce 27 yards per hour - with a distaff and a hook at the top of the spindle, 55 yards. Greek friends have made some very adverse comments on these rates of spinning.
to enjoy spinning, and today's attitude to it, which probably resembles the ancient one, is summed up in the rhyme:

"Το πέντεμα εἶναι γλέντεμα κι η ρόκα εἶναι τεργίαν,
Καὶ το τεκρίκι κι ο ἀργαλεός εἶναι εκλαρία μεγάλη."  

WEAVING AND LOOMS.

Weaving.

Weaving is the art of interlacing two sets of strands at right angles to each other so as to form a fabric or textile.

Long and involved arguments have been put forward to try to prove that the first weaving was derived from various types of netting and plaiting, some of them considerably more complicated than weaving itself, but this remains in the realms of speculation.  

Simple plaiting, of the type used to braid hair since time immemorial, may have given rise to some ideas on weaving, as, although only one set of strands is involved, each one, as it is plaited, is passed over one lock of hair and under the next. The minimum and most usual number of strands used in plaiting is three, but as many strands as the hands can manage may be used without any alteration in principle. Narrow, colourful strips of cloth were being made by this method in Palestine as recently as thirty years ago (Pl. LVIIIId).

1. "Embroidery is amusement, and the distaff, a stroll,
   But the reed-comb (?) and the loom are a great slavery."
   (The meaning of το τεκρίκι is obscure).
There is no evidence so far that matting and basketry are older crafts than cloth-making; but matting does occur in many of the earliest settlements, even in pre-pottery levels, and it seems possible that the first textile could have been a rush mat, the strands being interlaced on the ground, without any equipment or tools other than fingers.

It must have been difficult, however, to keep the first set of strands in place while the second set was woven in and out, especially when fine materials were being used, and a frame must soon have been invented to hold them in place while weaving was in progress. When this happened, the first loom had been invented, for a loom is by definition any apparatus on which threads are stretched for weaving.

The strands which are placed upon the loom before work commences are called the warp, the warps or the warp threads. The strands which are then woven in and out are called the weft, or, less frequently, the woof.

The looms on which the first warps were placed were probably very simple ones. The warp may have been stretched between two stakes hammered into the ground, or hung over the branch of a tree and weighted with stones.

The weaving must at first have been done entirely by hand, the weft being threaded over one warp and under the next, over the third and under the fourth, and so on till the end of the row. In the second row the weft had to be put over those warps it had previously passed under, and

2. Both words from the same root O.E. 'wefan' to weave - Shorter Oxford English Dictionary.
under those it had previously passed over, as in darning. These two rows had to be repeated ad infinitum. It cannot have been long before this was felt to be remarkably tedious, and some improvements called for.

The first of these would have been a shed stick. The warp may be thought of as being divided into two groups, the odd threads, and the even threads. If the odd threads are those passing above the weft in any particular row, the even threads will be those passing beneath it, and their positions will be reversed in the next row. Therefore if a stick is placed between the two groups of threads, with, say, the odd threads before it and the even threads behind it, it will preserve this division. This division or opening between the warps is called the shed, and the stick is consequently known as the shed stick.

The shed stick, however, only preserves one of the two possible openings between the two groups of warps; when the even threads should be in front of the weft, and the odd threads behind, it is useless, and every second row of weaving must still be laboriously darned in by hand.

This difficulty is overcome by the addition of a heddle rod. This is a rod which is laid across the warp, in front of both sets of warp threads. From it, loops are passed between the threads of the set of warps in front of the shed stick, and are affixed, one to a warp, to each thread lying behind the shed stick. The back or under set of warps may thus be pulled in front of or above the front set of warps by pulling on the heddle rod. The loops that attach the back warps to the heddle rod are called heddle leashes (Figs. 7a, b; 8a).
Both openings or sheds can thus be made quickly and easily, and weaving can progress with quite surprising speed.

It is not known exactly when these refinements were added to the simple loom framework, but a good case can be made out for their existence at least as early as the middle of the fifth millennium B.C. (page 88 below), and the fineness and quality of the Çatal Hüyük cloth would suggest that they were known there too.

There are two or three tools which are of great advantage when using a loom. The most important of these is one to pack the weft up closely as it is woven, and on the looms with which this thesis is concerned, this function was, and is, performed by a sword beater. This is a flat piece of wood, usually somewhat shorter than the width of the cloth being woven, and, as its name implies, often the size and shape of a sword (Fig. 8a). It is inserted between the warps after each throw of the weft, and beaten smartly against the last-woven thread (see left-hand figures in Pl. VIIIc, d).

A small, pointed tool called a pin beater is useful for separating warp threads when they stick together, and for correcting any irregularities in the distribution of the weft. The Bedouin sometimes use a gazelle horn for the purpose, and many of the pointed bone tools found on excavations would be eminently suitable.

A shuttle is not strictly necessary, as the weft thread can be wound into a ball or a hank, or onto a stick.

1. Shelagh Weir "Spinning and Weaving in Palestine", 1970; Pl. 13, left; Pl. 11.
2. Shelagh Weir 1970 op. cit., Pl. 14; Pl. 12; Pl. 11.
4. On pedal looms both the sword and the pin beaters are replaced by the reed comb.
but a special tool designed to hold thread is a convenience, and some small clay objects found at Middle Neolithic Knossos (Fig. 23a - c; page 189 ff. below) may well have served this purpose.

Many 'primitive' looms which must be ancient in origin still exist today, but only three major types can be proved to have been in use in the Mediterranean between the seventh and the first millenia B.C.: the horizontal ground loom, the vertical two-beam loom, and the warp-weighted loom. With one notable hiatus, the latter was the favoured loom of ancient Greece, both in prehistoric and in later times. All three looms are still in use today, the years bearing mute testimony to their efficiency.

Looms.

a). The Horizontal Ground Loom.

A painting on a dish from predynastic Badari (Pl. VIa), circa 4,400 B.C., provides the first proof of this loom's existence. It is the loom always depicted in Egyptian wall paintings and even models (Pl. VIb) until the time

3. Percy E. Newberry "Beni Hasan, Part I", 1893, Pl. XXIX, Tomb 3, Chnemhotep's Tomb, main chamber, west wall. Two crouching figures at a loom which appears vertical owing to lack of perspective, but far set of pegs is clear; Percy E. Newberry "Beni Hasan, Part II", 1893, Pl. XIII, Khety's Tomb; Part II op. cit., Pl. IV, Baqt III's Tomb, to right of spinners, two looms (?) with finished cloth (?).
of the New Kingdom, when a new type of loom, the vertical
two-beam loom described below, seems to have replaced it.
One of the later predynastic Badarian textiles, which had
1
88 x 50 threads per square inch must have been made on such
a loom, as must the extraordinarily fine First Dynasty tex-
tile from Abydos (page 82 above). The loom is still used
by both the Bedouin, to whose nomadic life it is well-suited,
and the villagers of Israel, Jordan and surrounding coun-
tries today.

The loom is very simple to set up. Two pairs of
pegs are driven into the ground the required distance apart.
A pole is laid behind each pair of pegs. These poles are
the beams, and the warp is stretched between them. The
warp threads are separated by a shed stick, and the set of
threads behind, or in this case, below the shed stick, is
lashed to a heddle.

The loom in the dish from Badari has all these
features. The two pairs of pegs and the beams are quite
clear. There is some woven cloth at the right-hand end.
across the centre of the warp are three bars which surely
represent the shed stick, the heddle, and the sword beater
(Pl. Vla). The same features are even more clearly seen
in the Middle Kingdom model of the weaver's shop (Pl. Vlb).
They are partly obscured in the modern picture (Pl. Vlc),
but the heddle rod is apparent, and the shed stick may be

1. Thomas Midgley in G. Brunton and G. Caton Thompson "The
Badarian Civilisation", 1928, p. 64 ff.
2. G. M. Crowfoot, P.E.G., 1945, pp. 34 - 46; Snelagh Wair
"Spinning and Weaving in Palestine", 1970, pp. 16 - 23,
Pls. 9 - 12.
3. There is indecision as to what the background figures are
doing. They look as though they might be hanging out
hanks of thread to dry.
observed just to the front of it.

One interesting feature of the modern Bedouin loom is that the heddle is kept in a permanently raised position on top of two large stones, the heddle-jacks. Thus the lower set of threads is kept in the upper position, and the upper set of threads has to be forced above them again by standing the wide, flat shed stick on edge (Fig. 7c, d). Heddle-jacks do not seem to be represented in any of the tomb paintings; there may be two in the Middle Kingdom model (Pl. VIb), but the heddle is not shown as resting on them.

The archaeological remains that would be left by such a loom would be few, if one postulates that all the wooden parts would have perished. The very most that could be expected would be the post-holes from the four pegs, the two heddle-jack stones, if such were used, and the pin beater. In practice it would probably be the pin beater alone that would survive.

There is no proof that this loom was ever used in prehistoric Greece, but it may have been in the Neolithic period, when loomweights were relatively scarce, and in the Middle Helladic period, when they appear to have been all but non-existent.

b). The Vertical Two-Beam Loom.

If Egyptian tomb paintings are a true reflection of life in ancient Egypt, this loom replaced the horizontal ground loom in the sixteenth century B.C. (Pl. VIIa, b).

1. For a slightly different method, Sheilagh Weir "Spinning and Weaving in Palestine", 1970, p. 18; Fig. 1a, b.
2. Grace M. Crowfoot "Textiles, Basketry and Mats" in S.H.H. Vol. I, 1955, p. 439; Fig. 277; H. Ling Roth "Ancient Egyptian and Greek Looms", 1913, Fig. 16.
it looks very similar to the carpet looms used in Greece (Pl. VIic), and other countries today.

The vertical two-beam loom is very like the horizontal ground loom in principle; it may be thought of as a horizontal ground loom set on end, with the two beams which formerly lay behind each pair of pegs held in a rigid vertical framework. Weaving commenced at the bottom, and the weft was beaten downwards. The details in the wall paintings are not perfectly clear, but it seems likely that as the cloth was woven, it could be periodically rolled up on the bottom beam, and more warp unrolled from the top beam, as happens today, so that the weavers did not have to rise from their sitting position.

In a country where organic matter perishes easily, this loom would leave no trace, and the pin beater would be the only one of its tools to survive. Again there is no proof that this loom was used in prehistoric Greece, but it was to be seen in Egypt at the time when Mycenaeans were trading there, and finds of Mycenaean loomweights are not so numerous as to preclude the existence of a second type of loom on the Greek mainland at that period.

c). The Warp-Weighted Loom.

The earliest recorded use of the warp-weighted

1. It is not clear from the illustrations how the heddle was used, whether it was moved backwards and forwards as with the warp-weighted loom, or kept in a fixed position as with the horizontal ground loom. The latter was the practice with a slightly different type of upright loom in use in Palestine thirty years ago - Shelagh Weir "Spinning and Weaving in Palestine", 1970, p. 26.

2. In Palestine a third beating tool, a heavy iron comb, was used on the upright loom mentioned in note 1 above, and this instrument is still used in Greece on upright carpet looms. It does not appear in the wall paintings however.
loom is probably once again that from Çatal Hüyük, and loomweights said to have been found at Nea Nikomedeia in Macedonia must be almost contemporary. By the end of the fifth millennium B.C., the loom was in operation as far east as Mesopotamia, and by the end of the third it was to be found as far north as Switzerland.

In Crete the warp-weighted loom was used consecutively from Neolithic to Roman times, and the same may be true of the other Greek islands, but evidence is scanty. On the mainland of Greece, its history is less clear-cut. Loomweights sometimes occur in the Neolithic period, especially in the later part; they are commonly found in Early Bronze Age levels; they virtually disappear during the Middle Helladic and the earliest part of the Mycenaean Ages; they reappear from Late Helladic II onwards, but only at a few sites, and not in great numbers. They may have been used in the Dark Ages, and on Geometric, Archaic, Classical, Hellenistic and Roman sites they turn up in their hundreds.

The warp-weighted loom is said to have become obsolete in Greece in the first century A.D., and in the Near East in the fourth century A.D., but in Europe its use continued until the Middle Ages, and it is still employed today in

remote parts of Norway and Lappland, giving it a history of more than eight thousand years.

The principles upon which a warp-weighted loom works are slightly different from those which govern the two looms previously described, although the component parts are similar. The basis is a rectangular framework consisting of two upright posts held by two cross-struts, one at the top, and another a little below the mid-way point (Figs. 7a, b, 8a; Pls. VIIIa, d, IXa, b). This framework is leant against a wall at an angle (Fig. 7a, b; Pl. VIIIb). There is a fork at the top of each post, and the ends of a rod called the cloth beam rest in them (Fig. 8a; Pl. VIIla). The warp threads are attached to this beam (see below), which can usually be turned to allow the work to be rolled up as it progresses. The warp threads are separated into two sets in the usual way, but one of them is passed in front of the lower cross-strut, while the other hangs vertically down behind the framework (Fig. 7a; Pls. VIIIb, Xd). The division thus made between the two sets of warps forms the first opening or shed, known as the natural shed (Fig. 7a; Pl. XIIa). Both sets of threads are weighted, in bunches, not singly, with loomweights (Fig. 8; Pls. VIIla, b, c, d, IXa, b); this of course forms two rows of loomweights. The heddle rod is laid across the front set of warps (well seen in Pls. VIIla, XId), and the back warps are attached to it in the usual manner (Pl. Xe). Rather more than half way up each post is a peg with a forked or notched end; these are the heddle crotches (Figs. 7a, b, 8a; Pl. VIIla, b). When the heddle is drawn forward and its ends are rested in these crotches, the back warps are pulled in front of the front ones, thus

creating the second or false opening or shed (Fig. 7b; Pl. Xlb). Work begins at the top and proceeds downwards, the cloth being formed by the weft being passed alternately through the natural and the false sheds. After each throw of the weft, the work has to be beaten upwards with a sword beater (Pls. VIIIc, d, the left hand figures at the looms; and XId); a pin beater is used for minor corrections, and shuttles may be used to carry the weft (Pl. VIIIc, d, the right hand figures; and Pl. IXa). Finished work can be wound up on the top beam (Pl. IXa, b, c), and more warp released from excess fastened to the loom weights (Pl. Xf). 1

When operating a warp-weighted loom, several other features were found to be of such assistance that it was difficult to work without them. The first of these was a temple, a stick pointed at each end and inserted into the edges or selvedges of the cloth to preserve an even width; without one the work gets gradually narrower (Pls. VIIIa, d, XId). Spacer chains, crocheted round each warp thread in both back and front groups (Fig. 8a; Pl. X/7) counteracted the tendency of the warps to bunch above each loom weight, leaving gaps in the fabric. Finally the two rows of loom weights were eventually fastened to rods to stop them twisting and jangling (Pls. VIIIId, Xf, Xla, b - cf. VIIIa, b).

Preparing the warps for a warp-weighted loom is quite different from doing the same for the other two looms referred to, on which it can be tautly stretched between two

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1. The work should be wound up when the shed openings have become so small that it is difficult to insert the shuttle and beater. This stage has been reached in Pl. VIIIId.
2. There is a slight tendency towards this in the top of the cloth in Pl. VIIIId.
3. In spite of the spacer chain, this tendency can be seen in the cloth in Pl. VIIIa.
beams. Cloth made on a warp-weighted loom has a twined starting- or heading-cord, or, more usually, a woven starting border. This has been the practice throughout the loom's history. A group of threads, somewhat longer than the width of the cloth to be woven, is stretched between two pegs, round which the ends are tied. A loop of warping yarn, drawn from a large ball, is woven through these threads, then pulled through, and passed round other pegs or posts until the loop is the length desired for the warp. The end of the loop is then slipped over the final peg (Fig. 8b). The process is repeated, and the result is a wide but shallow strip of cloth with a very long looped fringe (Pl. Xc), the fringe being the future warp. As work progresses, it is convenient to wind up groups of these long loops (Fig. 8b). When the required number of loops has been woven, the threads tied round the pegs are removed and their ends plaited, and the starting border is sewn to the cloth beam at the top of the loom (Fig. 8a). Because the warps are woven through the starting border in loops, they initially lie in pairs, and for a tabby weave, each of these pairs must be split, one thread going to the front and one to the back (Fig. 8b, detail). The ends of the loops are cut at this point. Thus while the warp is double in the starting border, it is single in the main body of the cloth, the difference being easy to discern (Fig. 8b, detail; Pl. Xc).

2. Marta Hoffmann 1964 op. cit., pp. 64 and Figs. 25, 26; 82 - 83, Fig. 35.
3. At intervals it is necessary to move the starting border along or to wind it up round the initial peg, and/or to move the pegs round which the loops are passed, to ensure that all the loops will be of equal length - see Marta Hoffmann 1964 op. cit., pp. 65, 84.
4. These plaits stick out at the two top corners of the finished cloth unless sewn down to the selvedges - see Marta Hoffmann 1964 op. cit., Fig. 77.
5. They are sometimes crossed, sometimes not - cf. Marta Hoffmann 1964 op. cit., p. 155, Figs. 71, 72; pp. 160, 161, Figs. 75a, b, 76.
starting border is thus immediately recognizable, and is as good evidence for a warp-weighted loom as are loomweights themselves.

The above description of the construction and operation of a warp-weighted loom is based on experience with two warp-weighted looms built as far as possible like those depicted on certain archaic and classical Greek vase paintings, but used in the light of modern Scandinavian practice. Four of the clearest illustrations are seen on the New York lekythos, (Pl. VIIIc), the Chiusi skyphos, (Pl. IXc) and two Boeotian skyphoi painted in the satiric style associated with the Kabeiric Mysteries, one, from the van Brantegham collection, in Oxford (Pl. IXa) and the other (Pl. IXb) in the British Museum. All four looms illustrated have a rolling cloth beam with a quantity of cloth already wound on. All of them except the New York lekythos show two rows of loomweights, but the latter has only one. The loomweights are tied, correctly, to bunches of warps, thick on the New York lekythos, schematic on the


4. H. B. Walters, J.H.S. XIII, 1892-3, pp. 77-87, Fig. 2.

5. H. B. Walters 1892-3 op. cit. Pl. IV.
two Kabeiric vases, but apparently attached to single threads on the Chiusi skyphos, which in fact is never done. Shuttles are being used on the van Branteghem skyphos and the New York lekythos, and a sword beater is wielded by the left-hand weaver on the latter vase, which is the only one on which weaving is actually in progress. The two Kabeiric vases show two horizontal lines apiece across the centres of their looms, which probably represent the lower cross-strut and the heddle - they are too long for sword-beaters (cf. their appearance with the loom in Pl. VIIId). The New York lekythos has a very evident heddle, with even the lashing threads of the heddle leashes clearly seen, but no cross-strut. Just above the heddle, however, is a thin rod, which may have served as a shed stick. One has the impression that the artist of the beautiful Chiusi skyphos knew rather more about painting than he did about weaving, as his wistful Penelope's loom is not a working model. There are the usual two bars across the centre, but all the warps pass in front of both of them, whereas half the warps should lie behind a shed-stick or cross-strut, and all the warps behind a heddle. There is an unnecessary extra cross-strut below the cloth beam, or else there are two cloth beams and two rolls of cloth on the one loom at the same time, an impossibility; and this is also the loom with only one warp thread per loomweight. It is interesting, however, for the complexity of the patterns displayed in the cloth.

Three of these four vase-paintings portray scenes from Homer, showing that fifth and fourth century artists thought of the heroic loom as being the same as that of their own times. Homer himself clearly had the warp-weighted loom in mind, as is proved by numerous references
to his heroines walking to and fro before their looms. This is necessary when the cloth is wide, to pass the shuttle from one side to the other, and, when the weights are numerous and therefore heavy, to lift first one end of the headdle rod into position, and then the other. With all other types of early loom one could sit at - or on - one's work. There is, further, a simile comparing Odysseus catching up with Alas the Lesser in a foot race to the weaving rod being drawn near the breast of the weaver, a description which fits the action of the headdle on the warp-weighted loom to a nicety. When the woollen warps of the cloth being woven in Pl. Villa, being too closely set, stuck together and refused to separate, dressing them with olive oil, a remedy which was suggested by Homer's passage about the weavers in Alcinous' palace, solved the problem.

Any machine which has maintained its popularity over so long a span of time must be possessed of certain advantages, and the advantages of the warp-weighted loom are many. It is easily constructed of simple materials, readily obtainable in most places. Being vertical, or

1. Iliad, I, 51; VI, 450; Odyssey, V, 62; X, 221.
2. Iliad, XXIII, 760 ff.
3. Odyssey, VII, 107 - "from the close-woven fabrics there drips off liquid oil" (tr. W. B. Stanford "The Odyssey of Homer", Vol. I, 1950, p. 324). This was the first piece of cloth woven, and the fault was due to inexperience, and to the poor quality of the wool, which probably contained an admixture of jute or synthetic fibre; but once the warps had been oiled, they slipped past each other easily. Widely-spaced warps are advisable on a warp-weighted loom, especially when wool is being woven (see Sir Leonard Woolley "The Beginnings of Civilization" Vol. I, Part 2, 1963, p. 539) but if closely woven cloth is desired, it is only possible to achieve it by this Homeric method. It may well have been a practice in prehistoric Greece. The warps had to be saturated at least twice a day, and the oil dripped down to an extent that necessitated newspaper spread below the loom.
4. The loom in Pl. Villa was built of driftwood, and that in Pl. Vliid, of firewood.
nearly so, it does not take up much precious living space when in use, and when the work is finished it can easily be dismantled and the component parts stored, or, if required, transported elsewhere. A 'double-width' cloth may be woven on it, and yet it can be adjusted to narrow fabrics. If equipped with a rolling cloth beam, as it usually seems to have been, reasonable, although not great lengths of cloth can be woven. The warp, although sufficiently taut, is more flexible than is the case with other looms, and portions of it can be lifted at will (Pl. Xic) without disturbing the rest of the fabric, an advantage in complex patterned and tapestry weaving. The preparation of the loom before weaving can begin (the weaving of the starting border, the arrangement of this and the attached warps on the cloth beam, the division of the warp into two sets, the attachment of the loom weights, the 'knitting' of the heddle leasnes, and the crocketting of the spacer chains) is tedious, as it is on all looms, including the 3 pedal loom generally in use in Greece today; but once the work commences, the machine is very easy to use, and the weaving progresses with surprising rapidity.

1. Iliad, i11, 125 ff; XX11, 445 ff. See also Pl. Wilic.
2. I estimate 10 - 12 feet to be the maximum; both lengths and widths of cloth can always be sewn together if larger pieces are required.
3. To stretch the warp on a pedal loom requires an afternoon and an evening, even when the warps are purchased prepared with a crossing (i.e. divided into two groups).
4. Remarks that the loom's operation must have been "not only difficult, but clumsy and tiring" (G. R. Admirand and D. B. Thompson, hesperid Supplement VII, 1943, p. 67) have little foundation. The rug being woven in Pl. Wilid measured 1.06 x 0.48 m. (3'6" x 1'7/8"), with 2 x 2 threads per sq. cm. (5 x 5 per sq. in.). It took two days to make, one for the setting up, and another, shorter one (5 - 6 hours) for the weaving. It did speed up the work to have two workers, one handling the shuttle, one beating up, and both shifting the heddle - but most of the work was done single-handed. The operators were not experienced, and possibly double the speed might be expected from professional weavers.
The loom is said to have two disadvantages. The first is that the beating-in of the weft is upwards, against the force of gravity, which is tiring, and makes it difficult to pack the weft very closely; the weft also has a tendency to sag downwards towards the middle (see Pl. VIId). The second is the already-mentioned fact that the weavers cannot sit at their work. It seems questionable, however, whether it is not worse to sit cramped all day with the knees against the chest, than to move about freely. Homer’s weavers, as they move to and fro before their great looms, singing in their sweet voices, do not sound discontented.

Such is, and such, or very similar, was the warp-weighted loom that dominated the early history of weaving in Greece and so many other countries. None of its wooden parts are likely to be found, few of its products remain, and perhaps for these reasons, its loomweights, its one certain legacy, have often been unrecognised or misinterpreted.

Loomweights. The first loomweights may well have been natural stones, but even when they are carefully selected for shape, it is difficult to tie the warp round them in such a way that they do not fall off. They must therefore either be notched to hold thread, or have holes drilled through them, both of which are tedious processes; or be replaced with more malleable clay. A very simple cylindrical shape with a slight narrowing round the middle is

2. Odyssey V, 62; X, 221.
3. The loom in Pl. Villia, b was originally weighted with beach pebbles, which worked well - their uneven sizes and weights did not affect the cloth. It was the fact that they were constantly slipping out of the warps and falling with resounding crashes that caused them to be replaced by the clay weights in Pl. Villia, b, d.
perfectly serviceable, and perhaps this type is to be recommended if the clay is to remain unbleached - but if the objects are to be fired, it is no problem to add the convenience of a hole to hold the threads securely.

Loomweights are therefore likely to be objects of clay or stone, which are pierced or notched to hold threads. They exhibit a great variety of shapes - cylinders, pyramids, cubes, cones, discs, spheres. They may weigh as little as 1 gram, as much as 5 kilograms. As they are used in groups, they are likely to be found in groups; scattered if fallen from an upper floor, in a jar or a heap if they were being stored, and lying in a line or lines if they were in use upon a loom when a site was destroyed or deserted.

Although correctly identified as long ago as 1846, loomweights have been subject to some extraordinary misinterpretations. The finest one is perhaps that which classifies them as identification tags for cattle. Others are: votive clubs and axes; votive cakes for the dead; counter-weights for trap-doors; heating or boiling stones

1. An unpublished E.B.A. pyramidal weight from the recent Servia excavations (No. 301, Fig. 36b) weighs 52 grams. Pyramidal weights from Knossos, but of Roman date, weigh even less.
4. E. Dodwell "A Classical and Topographical Tour through Greece I", 1819, pp. 34 - 35. The loomweight which gave him the idea had 'Aphrodite' inscribed on it - a charming name for a cow.
5. J. Hazzidakis "Les Villas Minoennes de Tylissos", 1934, p. 105, Pl. XXX i. It was this illustration that made me think that each row of loomweights was perhaps tied to a rod - see p. 93 above.
for keeping food warm; avoirdupois weights; and fire balls for slinging at enemies.

Their true use was established on a firmer foundation by a find of Carl Blegen's at Troy. In Room 206 of settlement Troy IIlg, he was both fortunate enough to discover loomweights lying in "almost orderly rows" and the holes left by the upright posts of the loom, and well-informed enough to recognize it for what it was (Pl. XXXVla).

Since the appearance of this publication, there have been fewer misrepresentations, but there is one error that still persists - the confusion of spindle whorls with loomweights. In spite of their common occurrence, these two classes of object seem to cause complete bewilderment in otherwise able archaeological minds, to the extent that a collection of spindle whorls may be published as loomweights; that the terms are used synonymously, so that spindle whorls, correctly so called in the text, may bear the caption "loomweights" under their illustration; that

1. G. Truhelka, Mitt. Bosnien Vol. IX (Separat-Abdruck), 1904, p. 37 ff.; several other theorists on this subject are quoted by J. Blinkenberg "Lindos I - Les Petits Objets", 1931, pp. 143 - 144. He himself does not agree with the theory.
3. Quoted by P. Neller (tr. J. E. Lee) "The Lake Dwellings of Switzerland", 1865, p. 66, Pl. XXI; he did not agree with the theory, and thought it "very fanciful".
the same object may be referred to by both terms in the space of a few sentences; or that one is faced with the already-mentioned impossibility of "spindle whorls for weaving".

The functions of a spindle whorl and loomweights are as different as those of a table and chairs, and if these functions are clearly understood, such faux pas as the above need not occur.

A spindle whorl is used to make thread. Loomweights are used to make cloth. The function of a spindle whorl is to act as a kind of fly wheel to the spindle, to add to its momentum and aid its rotation, on much the same principle as a child's top. The function of loomweights is to weight the warp threads hanging on a vertical loom, to keep them sufficiently taut while the weft threads are being woven in. Only one spindle whorl is needed to spin; but a set of loomweights - anything from ten to seventy in number - is needed for weaving. Size, shape and weight should all help to distinguish between the two classes of object. A spindle whorl must have a hole in a reasonably central position if it is to spin, whereas loomweights usually have a hole near the top.

3. The lower number is based on personal communication from Dr. G. Edelstein, who excavated a 10th century B.C. weaving village on Kibbutz Nir David in Galilee, Israel, where several sets of weights were found in situ. The greater number is based on Blegen's find at Troy (note 5, previous page), where 42 weights escaped destruction, and on calculations from vase paintings and numbers of weights found in houses at classical Olynthus - m. Bieber "Griechische Kleidung", 1928, pp. 12 - 13, Figs. 16, 17; Gladys R. Davidson "Corinth Vol. XII - The Minor Objects", 1952, p. 147.
The few spherical and cylindrical types of loomweight which are centrally pierced are almost always too large and too heavy to be mistaken for whorls. A further criterion is that the holes of unbaked or indifferently fired loomweights often show wear from the warp threads they have supported.

A more difficult distinction to draw is that between loomweights, net-sinkers and thatch weights, for both the latter classes of object are weights, and are used in groups, but even here a number of differentiations may be made. Thatch weights are unlikely to have been used in Greece's equable climate, and would naturally be found outside dwellings if found at all. They would have to be heavier than the average loomweight to be of much use, and be made of stone or exceptionally well-fired clay if they were not to disintegrate in wind and rain. The latter is even more true of net-sinkers, as Schliemann pointed out (pages 2-3 above) and it is doubtful whether even well-baked weights would survive hard usage and constant immersion for long periods. As a general rule, net-sinkers are unlikely to

1. Cf. weights of whorls, p. 81 above, with those of loomweights, p. 100 above. There is some overlap between the heaviest whorls and the lightest weights, but the two types of loomweight mentioned above are usually heavy.
3. Finds on prehistoric excavations in Greece suggest that roofing was often reeds plastered over with clay. Such roofs are still being used in remote places, and can be made sufficiently watertight if kept in repair.
4. An empirical average weight for the Greek prehistoric loomweight would be circa 200 - 250 grams.
5. Therefore the suggestion that the "badly fired clay rings" found in the lakes of Bienne, Neuchatel and Geneva were net-sinkers seems unlikely - J. G. D. Clark 1948 op. cit. in my opinion the only Greek prehistoric weights which could survive immersion would be the better-fired of the minoan ones, and some of the few mycenaean ones.
be found in houses, and obviously will not occur in inland, upland sites, far from both rivers and the sea.

The majority of objects regarded as loomweights in this thesis are of indifferently-fired, or sometimes unbaked coarse clay, and were found in groups, within buildings, and often enough at sites whose inhabitants would have had no immediate interest in either sea or river fishing.

Such were the three main looms on which all the cloth of the ancient Mediterranean world, coarse and fine, plain and patterned, was woven. It remains to be seen what types of weave could be produced on them.

WEAVES.

Cloth weaves.

A wide variety of both plain and pattern weaves can be achieved on the simple types of loom described above.

Tabby or plain weaves are those already described, where each weft passes over one warp and under the next in the first row, and under and over the warps in reverse order in the second row, and the two rows are alternated until the work is finished.

Pattern weaves are those in which this procedure is varied in some way. Wefts may pass over and under variable numbers of warps in three or four or more different combinations, as in the numerous forms of twilled weaves. This

1. Fishermen of the present day usually store their equipment in their boats, or on the jetty or shore, often in a shed specially constructed for the purpose. This seems to be the case even when they live close to the shore. Net-weights were however found in an Early Dynastic house at Khafaje in Mesopotamia - see J. G. D. Clark, Antiquaries' Journal Vol. XXVIII, 1948, p. 69, Note 5.
2. e.g. Vathypetro, Crete. See pp. 290, 303 below.
requires the addition of extra heddles, two plus a shed rod being the minimum number. Such weaves were used for woollen cloth in Late Bronze Age and Iron Age Europe, and could have been produced on all three types of loom under consideration, although those weaves requiring an uneven number of sheds are not well-suited to the warp-weighted loom. A workable and very ingenious arrangement of heddles has been suggested for the production of a complicated weave displayed by one of the Swiss Lake Village textiles, and loomweights lying in not two, but six rows in an Iron Age site in Israel indicate that patterned weaves were attempted on warp-weighted looms there.

Although such weaves cannot be ruled out as a possibility, there is no evidence for their use in prehistoric or even classical Greece. Such cloth as has survived is all in fine tabby (plain) weave (pages 249, 337, 411 ff., 458 ff. below) and vase paintings of looms show only one heddle, and, at most, two rows of weights.

So many different varieties of cloth can be achieved

3. F. Kelle (tr. J. E. Lee) "The Lake Dwellings of Switzerland", 1866, pp. 332 - 335; Fig. 18.
4. Seen in situ at Tel Sheva (Se’er Sheba), Israel, in 1970, on excavations directed by Prof. Y. Aharoni of the Institute of Archaeology, University of Tel Aviv.
5. For other types of pattern weaves used in antiquity, but not so far discovered or indicated in Greece, see Grace M. Crowfoot 1955 op. cit., pp. 430 - 431.
6. A piece of fifth century B.C. cloth from Eleusis, on display in the site's museum, has a self-stripe produced by using different qualities of thread; another classical fabric from Koropi, on display in the Victoria and Albert Museum, had a pattern of lions in a lattice framework embroidered on it - J. Beckwith, I.L.N. 23rd Jan., 1954, p. 114 - but the basic weave is tabby (or plain) in both cases.
on a loom equipped only with a single heddle and shed rod by introducing variety of colour and/or texture into the tabby (plain) weave technique, that the need for more complicated weaves may not have been felt. Variations on tabby weave include:

a). Tabby Weave. When this has equal numbers of warp and weft threads per square centimetre or inch, as in Fig. 9a, this is sometimes called 'linen weave', as this weave was and often is used for linen. It may be seen in any 'pure Irish linen' teatowel today.

b). Extended Tabby (Fig. 9b) is similar to the above, but has double threads in the warp and weft. It is sometimes known as 'canvas weave'.

c). Weft-faced Tabby (Fig. 9c). The wefts almost or entirely obscure the warp. This is most easily produced with fine, hard-spun warps set well apart, and thick, soft wefts packed close together.

d). Warp-faced Tabby (Fig 9d). The antithesis of the above. The thicker warps should be set close together, and the fine, unobtrusive weft should not be beaten in too hard. Horizontal ground looms are often used to produce a warp-faced weave.

e). Banded Tabby (Fig. 9e). This is produced simply by using several different colours in the weft. Different textures of yarn, thick, thin, soft-spun, hard-spun, over-spun (an irregular yarn inclined to snarl, which can look very attractive when woven in) can be used to add to the effect.

1. Much of the following, although based on experience, was originally derived from G. M. Crowfoot "Textiles, Basketry and Mats" in S.H.H. Vol. I, 1955.
2. The fabrics in Pls. VIIId and Xc are in this weave.
4. The cloth seen in Pls. VIIIa, XIc, d, had a tendency to be warp-faced.
which is best seen in a weft-faced weave.

f). Striped Tabby (Fig. 9f). Different coloured threads are used when setting up the warp. The weave is naturally more effective in warp-faced fabrics.

g). Checked Tabby (Tartan) (Fig. 9g). This is a combination of a striped warp and a banded weft, and as both should show to equal advantage, it is best produced in a 'linen' or 'canvas' weave. Once the multicoloured warp has been set up, this is no more difficult to weave than a banded weft. The stripes in the warp are simply repeated, horizontally, in the weft. Checks, some, as Sir Arthur Evans points out, very reminiscent of Scottish tartans, were used by both Minoans and Mycenaeans (pages 312, 470 ff. below) and were possibly popular in earlier times also (page 168 below).

h). Patterns in the warp (Pl. XXVc). A warp-faced weave is required, and warps are set up in two or more colours. Only those warps of the colour or colours required for that stage of the pattern are selected in each row, and the other warps are left to 'float' at the back of the work until needed. Quite complex patterns can be produced in this way, but they are inclined to be of a geometric type. 3

1. Twill weaves are also very suitable, and are generally used for Scottish tartans. Twill weaves have a greater diagonal stretching capacity than tabby weaves, and therefore adapt themselves better to the shape of the figure if being used for a wrapping or cloak. As stated (p. 105 above) there is no evidence for twilled cloth in Greece. Tabby weave, cut on the cross or bias, stretches better than when it is cut on the straight, and it is interesting that prehistoric Greek representations of tartan or check often show it cut on the cross (Fig. 75, Pl. LVIIIa, b).

2. P.M. I, pp. 430 - 431, Figs. 308, 309.

3. For a more detailed account see G. M. Crowfoot, P.E.Q., 1945, pp. 35 - 36, 39, 41, 44; Fig. 2.
1. **Patterns in the Weft** (Fig. 10a, b).

1) **Tapestry Weave.** This is probably the most versatile of all the pattern weaves. Almost any design desired can be produced in it, the only limits being the weaver's skill and patience. Instead of travelling steadily from one side of the cloth to the other, small sections of weft, of different colours, are turned back on themselves within the fabric, and woven backwards and forwards over a small number of warps only, according to the requirements of the pattern (Fig. 10a, Pl. VIIc). This may have to be done entirely by hand, but, if the pattern is at all repetitive, can be assisted by pairs of small stick-heddles, which lift only a few warps at a time. If the weave is coarse, these patterns may also have a somewhat geometric appearance (Pl. VIIc), but this is not noticeable in finer weaves. Penelope on the Uniusi skyphos (Pl. lXc) may have produced her realistic winged men, horses and griffins by this method, and Helen, egotistically weaving her great, purple, double-width cloth showing some of the many battles which the horse-taming Trojans and bronze-clad Achaeans were fighting for her sake, may also have found it suitable. It is interesting that both Homer and the painter of the Uniusi skyphos took it for granted that scenes of such complexity could be worked on warp-weighted looms. One authority suggests that the warp-weighted loom is the ideal one for woollen tapestry weaving.

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1. These are used on the upright carpet looms of modern Greece.
2. Iliad, III, 125 ff.
2). Pattern in Weft Floats (Extra Weft Insertion).

with this weave, the pattern may be worked into a warp-faced, weft-faced, or 'linen' weave. The best results are obtained if the basic fabric of the cloth, while not necessarily fine, is finer than the extra weft used for the pattern; the latter can be both thicker than the rest of the threads, and used double if desired.

The ordinary weft is passed through the opening or shed in the warps from one side of the cloth to the other in the normal way; then, while the heddle is still in the same position, the extra pattern weft is inserted by hand, and only where required (Pl. XiC). The heddle is moved to its other position, another ordinary throw of the weft is made, the pattern weft is inserted where required, the heddle is changed - and so on. If the patterned areas are widely separated, it is advisable to have several small balls or hanks of the extra pattern weft, but if the pattern goes right across the work, the extra weft can be allowed to 'float' at the back of the fabric where not required.

This method, like tapestry weaving, is very versatile, and, if the weave is fine, rounded patterns and life-like beasts and birds, and, no doubt, human figures, can be produced.

1. The main figure in Pl. XXVib has been made by this method.
2. I once watched a nun at the Convent of the Good Sisters at Kalamata weave a pattern of blue double-headed eagles into a white silk background using this method. The weave was exceedingly fine. The motifs, which were widely spaced, were each the size of the palm of the hand. Details like claws and flight feathers were shown. The weaver inserted the pattern entirely by hand, so rapidly it was difficult to follow her. I asked her to do it more slowly and she tried to, but found she couldn't. She said she used to count the number of threads needed when she was learning to weave as a girl, but when you got used to it, it was no longer necessary.
Painted figurines and frescoes provide glimpses of the prehistoric Greeks of some periods wearing patterned cloth - simple geometric patterns for the Neolithic mainlanders (page 168 ff. below), small, neat, widely-spaced motifs and patterned braids and borders on both this and plain cloth for the Mycenaean (pages 469 ff., 481 ff. below), and all these, plus some very ornate all-over designs for the Minoans (page 305 ff. below). There is none of these patterns, however, too complex to have been produced on a warp-weighted loom with a single heddle, using one of the methods described above. The pattern chosen for illustration of these methods (Fig. 10a, b) is one that occurs on Minoan, Mycenaean and Classical Greek cloth (page 478 below, Pl. VIIc, top centre, Figs. 56h, 79).

Matting and Basketry Weaves.

1. In Greece today both tapestry weave and extra weft insertion are used to produce patterns. The latter is perhaps more prevalent than the former, and may be seen in most parts of Greece. Its great stronghold, however, is Crete, where the patterns are more complex, more closely packed, and much brighter than on the mainland. Tapestry weave seems to be favoured by the north and particularly the north-west mainland. It is used by centres as far south as Arcadia and Delphi, and Agrinio, but the best examples come from Metsovo. The motifs are often small, neat and widely-spaced.

2. The exceptions are the coiled and wrapped techniques, which are in any case more akin to sewing than to weaving.

factor as far as variety of weave was concerned, as it would have been natural to confine cloth weaves to those which could be easily mechanised.

Matting and basketry, still largely made by hand even today, were not subject to this restriction, and consequently displayed a wider variety of weaves. Even this repertoire had its limits, however, for all the weaves that were used in prehistoric Greece were fully developed in the seventh and sixth millennia in one part of the ancient world or another. The same types have been found in all parts of the globe, from the Orkneys to Tasmania, from Spain to Peru; and all are still in use today.

a). Tabby (Plain) weaves. (Fig. 11a, b). Although the use of different materials may give tabby weave baskets and mats a different appearance, the principles involved are

1. Tabby (plain) weave mats are said to have been used on the house floors at Jarmo in Iraq (R. J. and L. Braidwood, Antiquity Vol. 24, 1950, p. 193; G. M. Crowfoot "Textiles, Basketry and Mats" in S.H.H. Vol. I, 1955, p. 418). Twined weaves are known from Mesolithic Europe (J. G. D. Clark "Prehistoric Europe - The Economic Basis", 1952, pp. 43 - 44, Pl. 11b, c), and from Nea Nikomedea (R. J. Rodden, I.L.N. 18th April, 1964, pp. 605 - 606, Fig. 9). Twilled matting was found at the same site (R. J. Rodden 1964 loc. cit., Fig. 10), and at Çatal Hüyük (H. Helbaek, Archaeology Vol. 16, 1963, p. 39 ff.). Coiled matting may be pre-Neolithic in origin (J. G. D. Clark 1952 op. cit., pp. 227, 229) and was used in pre-pottery Jericho (K. E. Kenyon, I.L.N. 12th May 1956, pp. 504, 506, Figs. 7, 9) and Çatal Hüyük (H. Helbaek 1963 op. cit., p. 45; J. Mellaart, I.L.N. 9th Feb. 1963, p. 198, Fig. 10).

3. H. Ling Roth et al. "The Aborigines of Tasmania" (2nd. Ed.), 1899, Chap. IX, pp. 143 - 144; Fig. 1 on p. 144.
exactly the same as those which apply to plain weave in cloth, and the same warp-faced and weft-faced variations may be made. Plain weaves seem less popular than others for matting, but they are well-suited to baskets, particularly those made of stiffer materials like twigs and cane.

b). Twined Weaves (Fig. 11c, d, e, f). In all basket and mat work, and especially in the twined weaves, it is not unusual for both warps and wefts to be multiple, each unit of the warp often consisting of a bundle of fine strands, and the wider, more pliable wefts being used doubled or tripled.

1) Simple Twine (Fig. 11c, d). Warps (or bundles of warps) are laid out parallel to each other. The weft consists of not one but two units or strands. One weft is passed behind the first warp, and one in front. They are crossed over so that they exchange places, and the weft that passed in front of the first warp, passes behind the second, and the weft that was behind the first warp is in front of the second. The crossing over of the two wefts between each warp gives the weft a very typical slanted appearance.

2) Split Twine (Fig. 11e, f). For this weave, each unit of the warp must consist of at least two strands. The first row of the weft proceeds as for simple twine. In the second row, however, the warp pairs or bundles are split, so that half of the first warp bundle is caught with half of the second. As this process is repeated, the work, if at all open, acquires an attractive 'honeycomb' appearance.
By using materials singly or in groups, and by packing the wefts loosely or tightly, a great variety of work can be produced by these two methods.

c). **Twill** (Fig. 12a, b, c). This weave has already been mentioned as a cloth weave in northern Europe from the Late Bronze Age onwards (page 105 above), but it was being used for matting as early as the seventh millennium B.C. at Çatal Hüyük and Nea Nikomedeia.

The simplest version of twill is a 1/2 twill. The weft passes over two warps and under one, over two and under one, till the end of the row. The second row repeats this, but the whole process is shifted one warp further to the left, or to the right. The third row is moved one warp further, and the fourth row, one warp further again, which in fact makes it a repeat of the first row (Fig. 12a).

Many other types of twill can be built up in the same way. In 2/2 twill, the weft passes over two warps and under two, and it is the fifth row which repeats the first (Fig. 12b).

The weave is capable of great complexity, and by altering the shift from left to right or vice versa in varying order, it is possible to form waves, herringbone, diamonds, and other designs, but this weave was not particularly prevalent in Greece. The most complicated example found so far is a 3/2 (or 6/4) twill, in which the wefts

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2. R. J. Rodden, I.L.N. 18th April, 1964, pp. 605 - 606, Fig. 10.
3. In Fig. 12a, the shift is to the left; in Fig. 12b, to the right; in Fig. 12c, to the left.
pass over four warps and under six, and each row shifts two warps to the left of the previous one, the sixth row repeating the first (Fig. 12c).

d). **Coiled and Wrapped** (Fig. 12d, e, f, g). This form of matting is not a true weave, as it is produced by a sewing technique, but when all other forms of matting are included, it seems pointless to exclude it from the thesis.

A long, flexible core of fibres is prepared, and coiled spirally round upon itself. Each coil is sewn, wrapped or bound to the preceding one by one of a number of methods. The most common is that in which the stitches pass round the new coil and pierce the coil before it between the stitches which bound it (Fig. 12d). Otherwise the stitches may pierce the previous coil through the stitches which bound it (Fig. 12e), or a wrapping strip may be passed right round the coil being fastened and the previous coil, binding them together (Fig. 12f), or the wrapping strip may be passed round the coil and looped through itself in a sort of button-hole stitch, after which the strip fastening the next coil can be passed through the loops thus formed along the outer edge of the previous coil, instead of piercing the coil itself (Fig. 12g).

The coiled and wrapped technique naturally produces a circular or oval mat, but it is not the only one that can do so. The plain and twined methods particularly, may easily be adapted to a radial warp instead of a straight one, and impressions of round mats made in all three techniques have been found in Greece.

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1. One in which the warp strands fan out from a central fastening, like spokes on a wheel.
The sections which follow are largely concerned with the tangible archaeological evidence for spinning, weaving and textile manufacture in prehistoric Greece. This would be robbed of much of its significance were the technical background not clearly understood. It is essential to remember that the many different types of whorls are not objects which exist in a vacuum, but were tools which were once used in one of the spinning methods described above; that implicit in them lies the cultivation and preparation of the fibres they once turned into thread. Mat impressions on pot bases are the mute witnesses to an understanding of the selection of suitable natural materials, and to the early development of a wide spectrum of weaving skills so satisfactory as to still be in use. Loomweights are not merely dull lumps of clay to be grudgingly assigned a small place in the 'miscellaneous' section of archaeological reports; they were once an essential part of the equipment of a very efficient loom which was capable of clothing whole nations for generation upon generation. Minor tools may provide side-lights on its use. Plain and patterned cloth depicted in Greek wall paintings not only testify to the versatility of this loom, but also portray a range of colours which indicate a wide knowledge of dye sources and their often complex preparation, for which other archaeological evidence is slight.

Thus archaeological finds, considered in the light of this technical background, can provide as complete a picture as is possible in our present state of knowledge.