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Ancient Forestry
An Historical Study, Part II
The Procurement and Trade of Forest Products

Olli Makkonen

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ANCIENT FORESTRY
AN HISTORICAL STUDY

PART II
THE PROCUREMENT AND TRADE OF FOREST PRODUCTS

OLLIMAKKONEN

Motto:
Ferrari, lignarii, dolorum cuparumque factores necessario halendii sunt, ne a labore solenni rusticis causa desiderandae urbis avertat.

Palladius I.6

HELSINKI 1969
PREFACE

Part I of my study on ancient forestry, which appeared in 1967, dealt primarily with biological information concerning trees. In part II we shall survey logging, the transportation and trade of timber as well as the procurement and trade of other forest products. These activities have been practiced for as long as the history of mankind is known.

To the following persons I owe a special debt of gratitude either for professional advice or for encouragement to take on a study of this sort: the late Rector and Chancellor of Helsinki University, EDWIN LINKOMIES, Professor ARMAS SALONEN, Professor ILIO KAJANTO, Assistant Professor PAIVÖ OKSLA, the Chancellor of Tampere University, EINO SAARI, and Professor VILHO PÖNTYNEN. These persons have rendered valuable assistance, which is not confined solely to the present part of my study, and I have acknowledged my separate debts to them in the preface to Part I. Following the publication of Part I, I have also received useful information on the source literature from Professor JAAKKO SUOLAHTI, Professors VEIKO HEISKANEN, KULLervo KUUSELA, SAKARI SAARNILJOKI, and PAavo Yli-Vakkuri have read the present manuscript and offered worth-while advice. I express my warmest thanks to each of them.

As in the preparation of the first part of my study, I have also written the present part in Finnish. I have again had the pleasure of turning the translation of the text into English over to Mr. ROBERT GOEBEL, with whom the joint work of tailoring the translation has progressed as smoothly as it did when Part I of the study was in its final stages. My warmest thanks to him, too.

As I mentioned in the preface to Part I of my study, I have received financial assistance from the Finnish Research Council for the Natural Sciences, which has subsequently been divided into several separate councils, the Finnish Research Council for Agriculture and Forestry and the Finnish Cultural Foundation. In addition I have been granted a smaller docent's stipend in Helsinki University for the purposes of my study. I wish to express my deep gratitude for this worthy support which has carried my study a long way forward. Separate mention ought also to be made of the Finnish Cultural Foundation's grant for the translation of both parts of the study.

Finally, I thank the Society of Forestry in Finland for publishing my study in its series, Acta Forestalia Fennica.

Helsinki, May 1968

Olli Makkonen
I. INTRODUCTION

A. General information

I have given an account of the background and initial stages of my study in Part I and shall not touch on them any further here. The first part of my study is based almost exclusively on the literature of ancient times. In the present part it has been possible to make use of the results of excavations and to examine other remnants of ancient civilizations, though written sources are again of prime importance.

In the first part of my study I have also treated in some detail the most important ancient written sources of information from the standpoint of forestry history. Therefore, the authors who figure significantly in the theme of the present part of the study will receive only brief mention.

Likewise, the modern literature on ancient forestry will be dealt with very briefly for the part of works treated in more detail in Part I of this study.

B. The most important ancient written sources from the standpoint of the procurement and trade of forest products

The «Iliad» and «Odyssey» are important sources of information on logging and wood transportation. «The Iliad» contains perhaps the first mention of the transportation of firewood on muleback. «The Odyssey», on the other hand, furnishes numerous facts on the primary conversion of wood. Hesiod, for his part, is perhaps the earliest informant on the proper time for felling timber.

One can find in the Bible references to the felling of trees, their transportation and trade, as well as the use of other forest products. The delivery by king Hiram of Tyre of cedar and cypress to Solomon for the construction of the temple is probably one of the biggest timber transactions in ancient times.

Herodotus, «the father of history» (ca. 484—425 B.C.), is not an especially important source as far as this part of the study is concerned but, nevertheless, there is reason to mention him in support of certain conclusions.

Aristotle in his philosophical heights has not dealt with matters of the sort with which the present part of the study is concerned, but Theophrastus (370—285 B.C.), his successor as the head of the peripatetic school, who was one of the most significant sources for the first part of the study, is again in the present context an important source of information.

Our first important source from the Roman world is Marcus Porcius Cato (234—149 B.C.). This fervent opponent of Greek culture and luxury of any sort was evidently a very economically oriented man because in many connexions he stresses the financial significance of forests. Also, Marcus Terentius Varro (116—27 B.C.) has here and there in his work «De re rustica» expressed thoughts that merit our attention as touching on the theme of this study.

Publius Vergilius Maro (70—19 B.C.) is a noteworthy source of information in virtually all matters concerned with forestry, and thus we shall make frequent reference to him in this part of the study, too.

The geographer, Strabo (63 B.C.—21 A.D.), who wrote in Greek, gives certain information which is interesting from the point of view of our theme. Titus Livius Patavinus (59 B.C.—17 A.D.) and Vitruvius Pollio (contemporaries of Augustus and Tiberius) have also been used as sources.

Gaius Plinius Secundus (23—79 A.D.) with his «Natural History» is here, too, one of our very most important sources of information. His contemporary, Lucius Iunius...
The Roman anthology of laws, *Corpus Iuris Civilis*, which Justinian, the emperor of the Eastern World, had compiled during the years 528–534 A.D. under the direction of the *Quaestor of the Holy Palace*, Tribonianus, should be mentioned in connection with this part of the study even though it is the author's intention, at a later date, to deal separately with laws in one way or another concerned with forests in ancient times. This anthology embraces four parts, 1. *Institutiones*, intended as an official textbook of jurisprudence, 2. *Digesta* or a collection of legal proceedings presided over by Roman jurists — and the decisions of these proceedings, 3. *Codex Justinianus*, a collection of imperial laws from the second to the sixth century A.D. and 4. *Novellae*, containing most of the laws of emperors Justinian's time.

### C. Related modern literature

Seidensticker's work *Waldgeschichte des Alterthums* (1886), to which numerous references were made in the first part of this study, has often merited our attention in this part of the study as well. That the present author's interpretation quite often differs from Seidensticker's is not to reduce the worth of the later's lengthy work. All writings must be examined against the background of a particular era, in the light of the actual possibilities offered by that era. It is to be especially noted that Seidensticker did not yet have at his disposal the results of excavations that were just getting under way in Egypt, the Fertile Crescent and Asia Minor during his lifetime. A modern investigator's possibilities of shedding light on the history of ancient times are thus essentially better than those of an investigator writing in the 1880's.

Sandermann's presentation of Seidensticker's work in the journal *Holz-Zentralblatt*, no. 29/1958, should be mentioned in this connexion. Certain of Sandermann's facts pertaining to the development of the saw are of especial significance from the standpoint of this part of the study.

Dreimel's (1925) study *Die altsumerische Bauwirtschaft* contains interesting information concerning the fact that the annual yield of the date palm served as one of the oldest known monetary standards.

Deserving of mention from the point of view of the history of tools and the use of wood is Feldhaus's (1931) work *Die Technik der Antike und des Mittelalters*, from which some of the pictures of this part of the study have been borrowed. Näslund (1937) has made use of Feldhaus's work as well as ancient literature in his paper on the history of the saw, *Sågar. Bidrag till kändedomen om sågarnas uppkomst och utveckling*. This valuable work gives a detailed account of the development of the saw from the Stone Age to modern times. Åbo (1945) has also briefly touched on the same matters in his paper on the repair and upkeep of forest saws.

Salonen's studies *Die Wasserfahrzeuge in Babyloniern nach sumerisch-akkadischen Quellen* (1939) and *Kaksoisirannnaos* (The Fertile Crescent, 1945), which were mentioned in the first part of the study, have once again been often used sources. The same author's study *Die Hausgeräte der alten Mesopotamier nach sumerisch-akkadischen Quellen. Teil 11: Gefässe* (1966) deals with various volume measurements, at least one of which was evidently based on the annual yield of the date palm.

Beekman's compiled work *Hout in alle tijden* should be mentioned in this connexion, though it will be referred to in the next part of the study, which deals with the use of forests in ancient times.

Hafner's survey of the water transport of wood in ancient times in his work *Zur Geschichte des Wassertransportes von Holz, besonders in Österreich und Deutschland, von den Anfängen bis zur Jetztzeit* (Zentralblatt für das gesamte Forstwesen, 1/1955) has served as a useful point of comparison in this part of the study.

The extensive English compiled work *A History of Technology* (Singer et al. 1956) has provided several pictures for this part of the study.

Deserving of mention as an especially worthy general survey of forestry knowledge in ancient Greece and of Theophrastus' significance for this branch of knowledge is Rünners' paper *Griechischer Geist und forstliches Wissen* (Allgemeine Forst und Jagdzeitung, 6/1965). The same author's survey of the development of silviculture in ancient times in his work *Forstgeschichte im Zeitalter der industriellen Revolution* (1967) is also very worthy of attention.

### D. Formal considerations

In the main, the worth and significance of a historical study based on available literature depends entirely on whether the sources in the original language have been interpreted correctly. For this reason the untranslated textual excerpts used in the preparation of this study have been card-indexed and presented as an appendix at the end of this paper. Direct quotations have also been in part incorporated into the text proper, but most often reference is made to the text in the original by using a superscribed numerical index. These indexes begin again with the number one for each main section indicated by a Roman numeral. By means of the Roman numeral at the head of each section and the index number of the footnote, the reference can be found in the original at the end of this paper.

The titles of written works appear in quotation marks, or when necessary, parentheses. Words in other languages occurring in the English language text have been printed in italics. The author names have been printed in small capitals, which has become a custom in the series Acta Forestalia Fennica.

In citing direct translations from the original languages into English, in some instances the translations which have appeared in the *Loeb Classical Library* have been used; the names of the translators in question will be found in the bibliography at the end of this work.
II. LOGGING AND TRANSPORTATION

A. Felling and primary conversion

To begin with, let us examine what in antiquity was thought the best time for felling trees. We find some references to this matter as early as the first half of the first millennium B.C. Hesiod (probably lived in the seventh century B.C.) says in his poem 'The Works and Days' that trees are least vulnerable to larvae when they have lost their leaves and that this is the time for felling. This is practical and apparently sound information, but we cannot so seriously accept Hesiod's recommendation that timber for construction and shipbuilding should be chopped down on the seventh day of the second third of the month (Works and Days, 805—808).

Here again Theophrastus offers abundant information. For example, he recommends barking of the round wood during the growing season. He says that the best time for felling round wood which is to be barked is at the beginning of growth because the bark is easy to remove due to the moisture that has collected underneath it. Later on the bark is difficult of removal and the wood becomes dark and unsightly. On the contrary, wood which is to be rough-hewed can be felled after the time favourable for barking because the ugly-appearance parts can be hewed away with an axe. The strongest wood is, however, obtained if the felling does not take place until after the fruit has ripened.

There were proper times for felling the various tree species and thus oaks, for instance, were chopped down later than other trees, as late as the end of autumn or early winter. If the oak was chopped down when the sap was running, it rotted more rapidly than at other times, whether barked or not. If chopped down after the acorns were ripe, larvae did not damage it, even though it was not barked. They did, however, penetrate under the bark and gauge figures in the surface of the stem, and such pieces of wood were used by some persons as signets.

According to Cato, trees were generally ready for felling when their seeds were ripe. The most suitable time for felling seedless trees (those not known to have seeds) was when their bark loosened. Trees which had at the same time both green and ripe seeds, such as the pine and cypress, could be felled in any season of the year. Our ancient Roman appears in this instance to have been indulging in ivory tower philosophy. Furthermore, quite after the fashion of Hesiod, he offers information that is completely fanciful. Among other things, he advises that construction timber should be felled in the afternoon when the moon was waxing and that the south wind should not be blowing at the time.

Pliny recommends that wood which is to be rough-hewed be felled during the period between our present Christmas and February 8 (a bruma ad favonium). If it was necessary to fell the trees before this time, this was best done when the Arcturus constellation was descending (about November 2), when the Lyra constellation was descending (about August 8), or else at the time of the summer solstice. In addition, Pliny says that it is extremely important to take into account the phases of the moon and goes on to tell the following about recorded opinions on the matter. Some persons recommend that felling of trees be carried out only during the period from the 20th to the 30th of the month. All agreed that the most suitable time for felling trees was when the moon was passing the sun, which period was called the interlunar day by some, the day of the moon's silence by others. In accordance with this rule the emperor Tiberius had ordered the felling of the larches used in the rebuilding of the pontis naumachius, the platform, destroyed by fire, which had been constructed across the Tiber for naval games. There were some of the opinion that when trees were being chopped down the moon had to be in line with the sun and below the horizon, which could only occur at night. If the moon's passing of the sun coincided with the winter solstice, wood chopped at this time would retain its durability forever.

As an example of how the wrong choice of felling time can cause more than just wood spoiling, Pliny mentions that door hinge pins of prematurely chopped olive wood were observed to reinitiate growth when the door had not been used for too long. This represents a rather careless attempt to provide a generalizing explanation for disconnected phenomena. To give an explanation was apparently more important for the savants of antiquity than the making of observations.

In the warm climate of the Mediterranean wood spoilage was a matter of which great heed had to be taken and thus much attention was focussed on the time of felling. Causes and effects were not known; but even so, it did not befit the dignity of the learned men to leave matters unexplained and therefore they fell back on the celestial bodies which, at a time when almanac and watch were lacking, otherwise played a vastly greater part in the lives of the people of the time than they do today. Nor have conceptions of this sort yet completely dropped out of the picture for as late as the 1950s writers has encountered professional forest workers of more or less foreman calibre who were dead certain that the summer felling of veneer birches should be carried out during a specific phase of the moon; otherwise, they maintain, the felled birch does not dry sufficiently or it acquires colour defects, and so forth.

Forest workers, who already in ancient times formed an especially important profession and without whom the savants would not have been able to write very much about forestry matters, appear nevertheless to have been quite underrated in many places. This seems to have been the case at least among the Israelites, for the Bible contains certain references to this effect. Let us cite the following passage (Deuteronomy 11) in which the spaced-out print are, naturally, the writer's: 'Ye stand this day all of you before the Lord, your God; your chief men, captains of your tribes, your elders, and your officers, with all the men of Israel, your little ones, your wives, and thy stranger that is in thy camp, even your woodcutters and your water-carriers,...'. The deprecation was apparently above all due to the fact that forest workers and water-carriers were in this case slaves; but, on the other hand, the fact that slaves were put to these very tasks is indicative of the social status of forest workers.

Hieronimus, whose Latin translation of the Old Testament (the Vulgate Bible) was completed in 404 A.D., evidently had an even lower opinion of forest workers in view of his translation of the above-mentioned passage: •excepting wood-cutters and water-carriers (exceptis lignorum caesoris, et his qui comportant aquas), an interpretation nowadays held incorrect. This, of course, be an accidental error in translation, yet on the other hand we can well imagine that such a misconception arose from the fact that the translator did not personally see wood-cutters and water-carriers as at all fit to stand before God.

Let us furthermore cite the following passage from the Book of Joshua (9:21): •Let them live, but may they become woodcutters and carriers of water for the whole nation. And further on (9:23): •Therefore cursed be ye! Let not any of ye be released from being a servant, (= a slave), a woodcutter, a water-carrier, in the room of my God.

In India forest workers seem to have belonged to the middle class, in so far as Sthala's report is reliable. To his knowledge there were seven castes in India, manual labourers [אָבְּךָ אֵל הַשָּׂדֶשׁ, אֶרֶבֶים] belonging to the fourth cast along with artists and small merchants.

Forest workers seem to have been made up of both slaves and free wage earners. The people of Gibeon who in the above-mentioned passage from the Book of Joshua were cursed and condemned to slavery were notwithstanding pardoned and made sthwood-cutters and water-carriers of the congregation and of the Lord's altars, which is to say that they were given the appropriate remanent free citizens, as is also disclosed in the following chapter of the same book. In passing let it be said that the newest Finnish translation of the Old Testament gives the impression of intentional embellishment by systematically making servants of slaves.
The previous Finnish translation of the Old Testament is thoroughly straightforward in this respect.

In the second century after Christ wood-carriers (dendrophores) formed their own guilds in Italy and Gaul. In a law instituted in 315 A.D. emperor Constantine united the guilds of wood-carriers, carpenters and cabinetmakers (Devêze 1961, Makkonen 1966).

In fairy tales and stories dating from ancient times the wood-cutter is nevertheless generally presented as the most mediocre of human kind and such tales are still read to children in our times. The underrating of forest work and workers has stubbornly persisted in the minds of even the most learned even up to the present century. As an example of this sentiment let us cite the view of the great Finnish statesman of the last century, J. V. Snellman: "Where there are forests, there is misery. Logging and the transport of timber can scarcely support anyone for even a day out of the year; it is labour which requires no mental effort and illumines but crudely their consequences." Not until this century, or more precisely, not until recent times have woodchoppers, those first instructors in forestry, received their due recognition. Only now has it been observed that intellectual effort and work planning have a decisive effect on the productive yield of forest work. Only now has it been realized that work in the woods is a profession requiring training just like any other profession.

In classical Greek there were several words meaning forest worker. Theophrastus uses the words ἀραξάρης (mountain woodman) and ἄλαγμος (wood-cutter, wood-craftsman). The last-mentioned word also occurs in The Iliad and in the works of Herodot. To indicate a worker who only felled treesSophocles uses the term δεινόμης (cutter of erect trees, tree-feller). In the Greek version of the Old Testament a woodcutter is called σαλόπος. All these words embody the meaning, to cut, to chop (ῥάπειν, τείρειν, κατέρ). Perhaps this reflects the fact that the Greeks made no use of the saw in tree-felling. Even in Finland, for that matter, the use of saws is such a recent development that we continue to speak of cutting-woods and wood-cutters. No until the introduction of the power saw has the word sawman been coined.

In Latin we do not meet with Greek compound words of this sort, unless we take into account Varro's offhand mention of the word lignicida (wood-cutter), which does not otherwise occur in Latin (Varro, LL. VII. 33: quid lapides caedent, lapicidas dicat, qui ligna, lignicidas dicit), which meant woodman as well as wood haulier or both combined, was very common. These tasks, especially in the case of firewood, were often combined such that the woodsmen set out for the forest with an ass or mule, felled trees, cross-cut and sometimes even split them up, loaded them on the animal's back, and hauled them straightway to the place where they were needed. Caesar uses the term lignator to indicate soldiers who were sent after wood. In the Latin translation of the Old Testament the terms ligna caedens (cutter of wood) and lignorum caesus (same meaning) are used. It could very well be that the verb, cedere: to chop, struck, took on the additional signification of felling for the very reason that trees were felled as part of the axe. The verb in question in fact also occurs in Latin in the simple meaning to fell (otherwise than by chopping). The word lignarius, which usually means wood merchant, sometimes occurs in the meaning wood-cutter or carpenter, as, for example, in the sentence chosen for the motto of this part of the study.

On the basis of archaeological finds, information on logging tools has been obtained from as far back as prehistoric times. Stone axes reflecting different stages of development are well-known. At first the axe-head was fastened to the handle with a spirg loop or leather thong. Later it was learned how to make holes in the axe head by means of a primitive, tube-like drill of animal bone and the axe-handle fastening was rendered much sturdier than before. The technique of fashioning axe-heads from hard rock than the generally used flint was also learned. Thus it was already possible to make axes of highly developed design (Fig. 1). Stone axes were used to make the piles, found as the remains of the prehistoric lakes, villages, particularly in Central Europe, as well as the wooden dwellings these piles supported.

The axes of Stone Age were not so uneffective as one could easily imagine nowadays. In a recent experiment in Denmark, a genuine Neolithic axe-head was fitted into an accurate modern copy in ash-wood of an original Neolithic haft. With this instrument, three men cleared 600 square yards of silver-birch forest in four hours; more than 100 trees were felled with one axe-head that had not been sharpened for about 4000 years (Russell 1967, p. 41).

Even well into the period of recorded history the axe (Gr. ἅλκη, πᾶλες, Lat. asa, secerns) was long by far the most important tool for work in the forest. The last-mentioned Greek term seems to have meant a double-edged axe for it is mentioned in Book V of The Odyssey (234—236) that both ends of the tool in question were sharpened:

δοκείν οἱ πᾶλες μέγας, ἔδρον ἐν παλάμοι, χάλκον, ἱματιάρειν ἄσπασμαν αὐτῶν ἐν αὐτῷ στελαχία πειρακτές ἔδρον, εὖ ἔννοιας.

Copper is mentioned as the material of the axe-head and, indeed, the events of the Greek epic are dated in the Age of Bronze. It is interesting to note that the kind of wood from which the axe-handle had been made is also mentioned. The Romans used the term bipennis (literally, double-edged) to designate a double-edged axe. As a synonym for the word axe the Romans often used the word ferrum (iron). Copper was to be sure, known in Greece, too, ever since the beginning of the first millennium.

In Fig. 2, which shows Egyptians involved in all stages of clearing a field, a man is also seen chopping down trees with an axe.

The principle of the saw also appears to have been known as far back as the Stone Age. The most primitive saw was presumably a sharp-edged stone occurring naturally, but later it was learned how to cut up and shape stones for this purpose as well as to put teeth in the sharp edge (Fig. 3). Ancient literature makes one reference to the use of sharp-edged stones as saws. In his account (based on the writings of Aristobulus of Cassandrea and Ptolemy Soter) of the voyage led by Alexander the Great's fleet commander, Nearchus, from the Indus delta along the northern coast of the Persian Gulf as far as the delta of the Tigris and Euphrates, Aristaeus (95—175 A.D.) mentions that the coastal dwellers on the territory of Oreitans (somewhat to the west of the Indus delta) used their nails as tools for cutting up fish and soft wood. For cutting down hard trees they used sharp stones. Iron was totally unknown to them. Pliny (VII. lvi. 198) credits a certain Daedalus, evidently the Daidalos (Fig. 4) of Greek mythology, with the invention of the saw, the axe and certain other tools. He is the fabled builder of the Cretan labyrinth from which the famed hero Theseus managed to escape by the aid of his beloved's ball of yarn after having slayn the Minotar. Pliny's contemporary, Lucius Annaeus Seneca, also mentions Daedalus as the inventor of the saw. The Athenian Apollodorus, who
lived about the middle of the second century B.C. and who was presumed to be the author of a work on Greek mythology entitled »Biblitheca« now thought to date no sooner than the period of the Roman emperors - , as well as Diodorus Siculus, a contemporary of Caesar and Augustus, mention as the inventor of the saw Daedalus' nephew, Talus, whose technically-skilled uncle had instructed him in the arts of his renown. Once when Talus playfully handled a snake's jawbone which was still complete with teeth, he observed that such a fearful apparatus might cut through wood. This gave him the idea of making a serrated tool of metal and resulted in his invention of the saw. The story goes that the uncle became so envious that he slew Talus.

The Roman librarian Gaius Julius Hyginus, also a contemporary of Augustus, as well as Plinius Ovidius Nardo (43 B.C. - 18 A.D.), the celebrated poet of the same period, also attribute the invention of the saw to Daedalus' nephew; however, they give Periix as his name. Furthermore, according to them the invention was based not on a snake's jawbone but on a fish's backbone. Let us give Ovid's verses concerning the subject in the Latin (Metamorphoses VIII, 244 - 246):

Ille etiam medio spinos in pise notatus
traxit in exemplum, ferroque incidit acuto
perpetuos dentes, et serrae repertit usum.

All Roman sources tell of the invention of the iron saw, though, in fact, the references from Greek mythology, so far as they are credible, are dated so far back that iron was not yet known at the time. The above-mentioned stories, which are also cited by the Swede Náslund (1937) in his work on the history of saws entitled »Silvar«, have recently in certain respects received somewhat of a basis in fact. It seems possible to locate these stories in the nearabouts of the ancient Cretan city of Knossos, where a great deal of excavating has been done lately. The German Sandermann (1958) relates that in the summer of 1957 he saw in the Iraklion museum on the island of Crete two saws discovered in connexion with the Knossos excavations: one of these was a two-man saw measuring two metres and the other a one-man saw of the same length; and both were fully comparable to modern logging saws in terms of shape. They were entirely of copper, thus apparently dating back as far as the third millennium B.C., or, the Copper Age of the culture in question. It is quite possible that the Greeks came into contact with the metal saw by way of Crete, where it in turn may have come from Egypt.

At the very beginning of recorded time, in the so-called Lagasha period of the first half of the third millennium B.C., it is known that the metal saw was used in the Fertile Crescent in preparing planks and in carpentry (Salonen 1945, p. 298). In Egypt, too, the saw was already known during the period of the so-called Old Kingdom (2580 - 2475 B.C.), at which time Memphis was the capital. Near Saqqara in the vicinity of ancient Memphis has been discovered a tomb, built about 2700 B.C. and decorated on the inside with reliefs, belonging to a priest named Ti. Fig. 5 shows a detail from these reliefs. It has been taken from Feldhaus' (1931) work, »Die Technik der Antike und des Mittelalters«. It depicts the work of carpenters, two of which are seen sawing a board in two. The man at the far left has lashed the board to be sawed to a sort of erect post in order to be able to grip the saw with both hands. According to Feldhaus' (1931) interpretation, a wedge from the top end of which a weight has been hung has been inserted into the saw kerf. The purpose of the weighted wedge would thus be to expand this kerf as the sawing progresses. Feldhaus suggests this as alluding to the fact that saw setting, i.e. alternate bending of the teeth in different directions whereby a saw kerf wider than the thickness of the saw blade is achieved, was not known at the time. Náslund (1937) agrees with this view. It actually seems, however, that the wedge was not inserted in the kerf but between the lashings and the board to be sawed, apparently so as to make the lashings tight and hold the board firmly in place. This is seen still more clearly in a relief, found in the same tomb, depicting sawing in connexion with shipbuilding (Fig. 7). Why the need for such a contrivance merely to expand the saw kerf? By means of the small wooden wedge at the top end of the saw kerf this can be accomplished in short order without weights of any sort.

A wooden wedge or stick has actually been used in this way, as is revealed by Fig. 6. It depicts a miniature model, found in the tomb of Pharaoh Meketre, of a carpenter's workshop. One of the men is sawing lengthwise a plank fastened to an upright post. A stick has been inserted into the upper end of the kerf to make the sawing easier. The position of the sawyer seems to point to the fact that the teeth of the saw are arranged in such a way as to give a more effective bite when pulled than when pushed.

In Fig. 5, another sawyer, who has not
fastened his board to anything, indeed seems to be trying to expand the saw kerf with his hand, as Näslund says, and may have even put his fingertips into the saw kerf; however, on this basis one would surely not venture to conclude that saw setting was yet unknown in this period. At any rate expanding the saw kerf certainly helped to facilitate the movement of the broad and still quite thick-bladed saws of the time, especially in hand sawing.

Dating from a considerably later period, the so-called New Kingdom of Egypt (1600—1100 B.C.), is a picture (Fig. 8) that shows a man sawing a board fastened to a short stake. The saw is markedly more modern appearing than in the previous picture. The position of the sawyer is decidedly brisk and nothing pointing to the expansion of the saw kerf is to be noticed. It seems evident that saw setting was known, at least in this period. Näslund (1937, p. 18) indeed observes that in Egypt even at such an early stage the saw blade can be considered to have in principle attained structural perfection, its further development being, as it were, no more than a question of materials. Sandermann (1958) does not mention whether the copper saws found in Knossos were set.

The first written reference to saw setting is probably from Theophrastus. He says that in sawing over-green wood the saw kerf becomes clogged and the sawdust catches in the sawteeth, obstructing the spaces between them. For this reason the saw teeth are alternately bent in different directions in order to get rid of the sawdust. A similar reference by Pliny is found in Roman literature.

To all appearances the saw was nevertheless not used in felling trees in ancient times to any extent worth mentioning. No known reference is made to the subject in written sources. In so far as mention is made of the logging tool, it is always an axe. To be sure, the saw (Gr. παλώρ, Lat. serra) is mentioned now and then, but facts about its use generally appear to refer to longitudinal cutting and sometimes also to the cross-cutting of felled trees. In the Kouyunjik excavations near Nineveh there has, however, been found in Sanherib’s palace a seventh century B.C. relief, a detail of which (Fig. 9) would seem to show quite clearly that the saw was not an entirely unknown tool in logging work. This detail shows three men, the first of whom is carrying on his shoulder a type of two-man saw as well as two axes. According to Näslund’s view, the men are apparently on their way to fell trees. If this were so, it might nevertheless be asked why each of the two men walking behind the tool-carrier has a forked stake. It seems evident that this is a case of felling trees in a precise
direction, which is to say the chopping down of garden or park trees, not forest work. However, even this interpretation may in fact be erroneous because the picture in question is a small detail from a large relief depicting slaves transporting a colossal statue by sled (Fig. 17, p. 26). Among other things, the picture portrays a large log, used as a lever, being held in position or raised by means of forked stakes in the same fashion as present-day telephone and electricity poles. Such being the case, the forked stakes are probably not to be thought of as implements for pushing down trees but rather the opposite. Moreover, the same relief reveals that logs were placed lengthwise in front of the sled with the evident purpose of reducing friction; the logs were then pulled out from behind by hand, carted to the front of the sled again, and the procedure repeated. It is clear that in operations of this magnitude, it was necessary to take many kinds of tools along, axes and saws, for instance, if for no other reason, in case the sled got stuck, which is most likely the situation depicted here. The need of cutting trees may, of course, have presented itself on the way, but our industrious-looking little group of workers probably does not enable us to draw the conclusion that the saw was, strictly speaking, used as a logging tool.

The Bible (Isaiah 10:15) makes a figurative mention of the axe and saw side by side (Shall the axe boast itself against him that hewed therewith? or shall the saw magnify itself against him that shaketh it?) but this can hardly be taken as an indication that the saw was used as a logging tool.

One of the men in the Egyptian relief presented by Beekman (Fig. 10) might perhaps be thought to be in the posture of sawing, but since the tree is already falling, he might equally well be striking the final blows to sever the tree from the stump. The obscurely seen tool gives more or less the impression of being an axe.

In Virgil's work (Georgics), which appeared in 29 B.C., there is a reference that seems to point to the fact that the saw was primarily used in longitudinal cutting of wood. In portraying the progress of civilization, Virgil mentions the discovery of iron tempering and the gleaming saw blades resulting therefrom, and he makes the observation that previous to this trees were split by using a wedge.13

Palladius, a Roman who lived in the fourth or fifth century after Christ, mentions as farm tools small hand saws no longer than an ell in length. These could be used to do cross-cutting, which was not possible with an ordinary saw.14 By an ordinary saw he apparently means a saw fixed in a frame (see Fig. 11). Such a saw was especially well adapted to lengthwise cutting of wood and the blade could be considerably thinner than the blade of an unfixed saw. Would Palladius' observation have really been necessary if the saw had been a generally-used tool for felling and cross-cutting trees?

Iron saws, too, surprisingly highly-developed though they were, nevertheless were probably still in ancient times so thick, hard to push and quick to dull that it was quicker to fell a tree with an axe than with a saw. Furthermore, sharpening saws probably involved so much work as to be an obstacle to taking them along to the logging site, which was usually situated far from inhabited areas. The file (Lat. limus) was indeed known but it was probably not very efficient because as far as Pliny knew, a be-goat's blood was so potent that it was more effective than a file in smoothing down the rough surface of an iron tool.15

In this connexion there is reason to bear in mind the fact that in Finland as late as the turn of the last century it was necessary to undertake great preparations before the old loggers would consent to take a saw with them into the forest. For example, according to the word of Prof. Erkki Laitakari, as late as 1917, the crofters of Rautalanpi rectory cut all the firewood for the rectory with only an axe.

Because in ancient times the saw was not used as a regular tool for forest work, the axe was also used in cross-cutting. This was presumably done at the logging site no more than facility of hauling required. Seidensticker (1886 II, p. 320) says that cross-cutting in the forest was done either with an axe or a set saw and cites Pliny with reference to the saw. The passage from Pliny's work (XVI. lxxxiii.227) referred to by Seidensticker in this context is not, however, in the least concerned with forest work but deals with carpenters' handling of wood. Nor does the passage from Herodotus' history (VII. 36) to which Seidensticker...
makes similar reference, speak of forest work but of the building of a bridge. The German writer would also seem to be informed on such a matter as the way measurements of trunks were taken in Greece and Italy in ancient times. He says that the measuring was done in terms of foot, hand, palm breadth, finger thickness and inch and that the cutting points were marked off with red chalk. The measurements were taken with a measuring stick or string or even with a pair of compasses. He does not cite any authorities with respect to the units of measurement and the red chalk. In support of the use of a measuring string he quotes Isaiah 34:11, where it is said: «But the morant and the bitter shall possess it; the owl also and the raven shall dwell in it: and he shall stretch upon it the line of confusion, and the stones of emptiness».

To persuade the reader that a measuring string was really used in measuring fallen trees and that a pair of compasses was also used for the same purpose, he refers to Isaiah 44:15-10. The measurements were treated as the Roman apertae (to fit, adapt, e.g. according to length), but to the writer's knowledge the word was already used by Virgil in more or less the sense described above. Virgil's verses touching this matter are as follows: (Aeneid I. 551–552)

\[\text{quassastam ventis ticeat subducere classem et silvis aptare trabes et stringere remos.}\]

Fairclough's English translation of this runs thus: Grant us to beach our storm-battered fleet, to fashion planks in the forests and trim oars, to fit, adapt. Referring to this passage, Seidensticker (p. 308) expresses his surprise that the phrase «to use the view tree and used was in the immediate vicinity of the logging site and then the construction timbers could be hewn as soon as they were felled». Odysseus had such a fortunate opportunity when he began building a ship in the house of Anchises and the timbers were hewn from the snares of Calypso and sail home (V. 237–245, translated by Geo. Chapman):

A plainer then. Then led she, till they came To lofty woods that did the confines. The trees still later, who bettered pine, Had there their offspring. Of which, those that were Of driest matter, and grew longest there, He chose for lighter sail. This place thus shown, The Nymph turn’d his home. He fell to felling down, And twain in little space, Tho’ plain’d, his used plumb, did all with artful grace.

Thus, a broadaxe (Gr. ἀξίων, Lat. ascia) was used to hew the wood and the surface made straight by means of a tightly-stretched cord.

Seidensticker (1886 II, p. 320) conjectures that Palladius' agricultural calendar (De rustico) explicitly reveals that large-sized trees were hauled intact. In support of this notion he has quoted from the Latin of the 7th-century manuscript of the four books concerning the transfer, roots and all, of large, still-living park trees to another location. The passage furthermore comments on the need for copious fertilization and irrigation. The mention of beimng of branches made in this context (truncatis rami) may have misled my German colleague.

The relief seen in Fig. 12 appears most prominent from the viewpoint of our study of ancient logging tools. It depicts, among other things, a buck saw, a cross-cut saw, a single and double-edged axe as well as other kinds of implements more or less reminiscent of picks; these latter are, however, wood-working tools (dobolra and ascia). Nevertheless, in question here are not the tools of a logger but, rather, those of a construction carpenter. Most surprising of all seem the dome-shaped objects two of which are hanging in the handles of the tools leaning against the wall. It is difficult to conclude otherwise than that workmen's hard hats, what is more, of a type provided with neck and ear guards against the hazard of flying splinters, were known already in imperial Rome!

Furthermore, chopping dry wood with an axe produces such a racket that carpenters working close beside each other perhaps had good reason to keep a close watch afoot. Are there no sound counts, too. How far has worker protection really progressed since those times? The two hard hats at the bottom of the relief appear to lack the above-mentioned guards and it is not impossible to imagine them as sawyers. The use of hard hats in construction work already in these times would not have been especially remarkable because the importance of the helmet in battle was, indeed, already known.

The stone seen in Fig. 12, which according to Gummerus (1913) is a votive stone and which is preserved in the Capitoline museum, was likely originally housed in the meeting hall of the Roman Carpenters' Union (capite rum fabrum tignariorum), though it was found in the church of San Giorgio in Velabrum. The face side of the stone has deteriorated badly, but the inscription thereon nevertheless reveals that it was erected as a monument in the second five-year period of the Union's existence. Since it has been possible to fix the date of the founding of this Union at 7 B.C. (Gummerus 1913, p. 101), the inscription very nearly coincides with the beginning of our calendar. Viewed from in front, the side seen in Fig. 12 is the monument's left face, and it has been preserved the best. The monument was
erected to Minerva, who, besides being the goddess of the arts and sciences (as identified with the Greek goddess Pallas Athena, Minerva was also the goddess of war), was also the goddess of the manual crafts. This fact is revealed by the right side of the monument, which depicts two figures holding high a small picture of Minerva. An allusion to Minerva is also seen in the helmet at top centre of Fig. 12; this was one of the symbols attaching to Pallas Athena as well as to the Roman Minerva, later identified with her. At the left of this helmet is the curved staff of the augures (interpreters of auspices or signs) and at the right is a sacrificial knife.

In the German journal, «Hölz-Zentralblatt» (Beilage Dec. 22, 1961, Die Entwicklung der Säge) an anonymous writer has presented a drawing, made on the basis of the relief seen in Fig. 12, in which the tools and the hard hats in particular have been modernized perhaps even a bit too much.

If we take into account the preparation of meals, making of fires, fashioning of axe-handles and many other tasks that take place in the forest, we must conclude that forest workers must have been provided with some sort of knife ever since the very earliest times. Already in the first century knife-making was, at least in Rome, a high-level and apparently also very profitable enterprise because, to cite an example, the knife-maker Atimus was wealthy enough to erect unto himself and his freed slaves a handsome grave-stone portraying his craft (Fig. 13). On the other side of the stone is a picture showing the work of making knives in progress. Judging from the knives in the relief, Atimus definitely had the eye of a designer.

In forests located in the nearabouts of farms, small-sized wood that was to be hauled on the back of a beast of burden or by cart may have been converted into finished wooden goods on the spot. However, even in cases of this sort long logs were often brought to the farms, where the finishing work was finally done. For example, Columella relates the following: «One worker is capable of felling, cleaning (i.e. lopping of the branches and barking) and sharpening one hundred fence poles a day; on the other hand, a man can split, hew on both sides and sharpen sixty vineyard poles of oak or olive-wood in the same time. He can likewise prepare ten fence poles or five vineyard poles by artificial light in the evening and the same number by artificial light before dawn.»

Here, then, Columella first speaks of making of round poles for fences in the forest and then of making of both vineyard poles as well as fence poles on the farm, even by artificial light after nightfall. Logging work is still not very alluring but, nevertheless, some social reforms indeed seem to have taken place times.

Columella’s above-cited account tempts one to deduce many sorts of things. First off, it is intrinsically interesting because it clearly mentions a man’s daily work output; furthermore, when doing two different types of work. In addition, it seems to enable us to deduce something about the proportion of felling and lopping work involved in making poles that were barked and sharpened. Columella says that the daily work-output ratio of round poles made from erect trees (felling, lopping, cross-cutting, barking, and sharpening) to vineyard poles made from long logs (cross-cutting, splitting, hewing, and sharpening) is 100:60; but if both of these articles were made on the farm from long logs hauled there, whereby felling and lopping were, thus, eliminated from the work of making round poles, the ratio was 105:60. According to the usual long logs as material, 60 vineyard poles would have corresponded to 120 fence poles; hence, the daily work output when the posts were made from erect trees was about 17% smaller than that obtained when making them from long logs. Conversely, this per cent figure expresses the proportion of time required for felling and lopping of the total time for preparing round posts in the forest. On the basis of modern-time studies on logging work, this seems quite credible.

The making of poles being under discussion, it ought perhaps to be observed that in ancient times barking was done with an axe (see note 6 of this chapter). We find no mention of a special barking tool in ancient literature.

The Romans used the general term putare (to clean) to indicate the lopping and barking of trees. In modern Latin dictionaries the word putare — to be sure, it has various meanings — in this context is assigned the meaning «clean of branches, lop», but nothing is said about barking. However, it is evident that the word also meant barking. For example, Varro urges that the «cleanings» of trees be done in winter, but not during a period when the bark is frozen. It is a perfectly well-known fact that barking is determinatively more difficult when the bark is frozen than when it is unfrozen. Conversely, freezing temperatures facilitate the lopping of branches and thus there was no cause to warn against doing this work when the bark was frozen. Columella, uses the verb exputare in the above-cited passage dealing with the making of fence posts, and it is obvious that these posts were stripped of bark because they would have deteriorated most rapidly.

Columella’s information also enables us to infer the length of a work day. In question here are farm tasks done in mid-winter, or more closely, in January. The use of artificial lighting is due to the fact that in Italy, too, the day is a good deal shorter in winter than in summer. In Mediterranean lands the sun is above the horizon for about 9 hours in January. This time may be considered the length of a normal work day. Based on the work output for vineyard poles the length of both the morning as well as the evening «rocklight shift» was thus 5/×9 = 1/2 hour and, therefore, we arrive at about 10 1/2 hours as the length of the whole work day.

Pliny, who was Columella’s contemporary but who wrote his natural history later
than Columella wrote his work on agriculture and used the latter as a source, informing us that the daily work output for vineyard poles was 30 pieces and the corresponding output for corn poles, 60 pieces. Here both articles are assumed as being made from long logs. The ratio is the same as that given by Columella, but the daily work outputs themselves are smaller by a half. However, for work done by artificial lightning Pliny gives the same figures as Columella. If the forest workers of ancient times had had modern-type labour unions, they would have certainly used Pliny as their expert advisor and bargained; whereas management, on the other hand, would have based its argument on Columella.

In all seriousness, this discrepancy may be due to the fact that Columella was a specialist in agriculture whereas Pliny was a general investigator interested in all fields. Columella apparently had an estate-owner's mentality to such an extent that he demanded the greatest possible output from his workers; by contrast Pliny, as the broad-minded investigator needed to have made every effort to provide a better effort at moderation. Departing from the fact that there was 9 hours of daylight we obtain as the time for making one barked and sharpened pole from long logs 4.5 min. according to Columella and 9 min. according to Pliny. An average Finnish forest worker equipped with modern hand tools can turn out 80—100 two-meter barked bolts of pulpwod from lopped long logs in roughly seven hours, which represents a rate of one bolt every four or five minutes. When it is taken into consideration that the posts mentioned by the Roman writers were made entirely with an axe and that they were, in addition, sharpened, Pliny's view really seems more reasonable. The posts in question were probably not very large in size.

Columella also gives information on the daily work outputs achieved in woodyards. He relates the following: 'If the wood is oak, twenty feet ought to be hewn to precisely square shape by one workman in a day; this will make a wagon's load. Twenty-five feet of pine-wood can be finished in the same condition by one man and this is also called a load, and likewise thirty feet of elm or ash; and forty feet of cypress and also sixty feet of fir-wood and poplar can be hewn to precisely square shape by a single workman, and all these amounts are likewise called loads.' Quite a number of various woods are here ranked according to relative difficulty of hewing and the estimates given seem by large credible. The ranking of pine as the most difficult seems a bit surprising, but perhaps in Mediterranean lands pine grows on sites so much poorer than those of the other tree species mentioned that compared to these trees it, as a fine-grained tree rich in late wood, is really hard to hew; or at least this held true for the broadaxe of the period. Modern woodyards no longer turn out such stout beams apparently used in construction work in ancient times. The stoutest so-called German timbers or square balks which Finland still to some extent exports to Germany and Denmark are probably 7 x 7 inches in thickness. Before the First World War beams up to 12 x 12 inches thick were still hewn in Finland. If, starting with the production figures of those times, we compute the daily output for, say, 10 x 10-inch pine balks, the result obtained is about 45 loads per man. This was not the result for pine balks reported by Columella. The comparison is naturally quite summary because there was no knowledge of the average size of hewn balks in ancient times.

The Englishmen Fouriers and Heffner, who have translated chapters V—XII of Columella's work into English, have rendered the first sentence of the above-mentioned passage (Lat. Materies si roborese est, ab uno fabro doliari ad ungueam quattuor pedum: pedum XX, hoc erit 40 unus.) as follows: 'If the wood is oak, twenty square feet ought to be perfectly hewn by one workman in a day: this will make a wagon's load. They are speaking, however, of square feet; in other words, they have construed the words per quadrata (squared, square-wise) and the expression of measurement, pedum XX, together. Grammatically speaking this is perhaps possible, but for my own part, I consider it obvious that the words doliari ad ungueam per quadrata belong together and should be translated in the manner of the above (note 20) i.e. hew to precisely square shape, hew a beam the cross-section of which is exactly square in shape. Now the same matter has been repeated in the latter part of the passage translated above and the slightly different form of the original Latin (obies atque populus ad ungueam quadrantur) is so straightforward that there should no longer be any room for difficulties of interpretation. The English translators have rendered this quite literally (can be perfectly squared), so that it is impossible to know how they have understood the passage in question. Bearing in mind the facts pertinent here, it is extremely unlikely that the daily work output in woodyards would have been given in square feet of the surface hewn. The measuring and computation involved would have been far too complicated. In so far as I am correct, this is a good example of how unfamiliarity with a specialized field can cause language specialists to fall into error.

Another seemingly odd fact is perhaps also deserving of consideration; namely, that Columella says that all different-sized quantities of the wooden goods mentioned are to be called loads (vehis). The gist of the matter is apparently that the author was really only concerned with finding a designation (quae et ipsa vehis dicitur; omnus ex eo mensurabat) and it was not an absolute matter of making loads of the sizes mentioned. It is not even thinkable that long, stout construction beams would have been loaded on any kind of ordinary, two-wheeled cart in farm work. So far as such goods were transported by vehicle, a good road and special vehicles of strong construction were needed and in this case the loads were surely greater than the daily work yields mentioned. Besides, the timbers were usually cut to shape at the construction site.

It may be that in all work connected with the procurement and treatment of timber, the daily work output of one man had come to be called a load. Getting firewood was one of the ordinary chores on a Roman farm. In the earliest times the practice was to take a draft animal into the forest, fell, lop, and cross-cut to suitable length as much wood as the beast could carry, then load this on the beast's back, make it fast and return home. Since the way was often long and difficult to travel, this task took a whole day. Even if the work took less than a day, the woodsmen, having got out of sight of their overseers, likely knew how to make the most of a good opportunity and had a welcome daytime snooze. To all appearances there evolved the general practice of making one trip to fetch wood in the course of a day. Apuleius, for one, gives such an impression in his novel known under the title of The Golden Ass (VII. 17—24). Later two-wheeled carts were used in this work, providing the terrain could be managed, and accordingly the daily work yield was a load of wood. Perhaps this is the reason why the daily work output in woodyards, too, came to be called a load.

Seidensticker has his own way of interpreting the matter. He says (1886 II, p. 324) that the carts accommodated one 20-foot oaken construction beam or one 25-foot pine timber and so forth all the way up to a 60-foot poplar timber. Taking into consideration the fact that 60 Roman feet equal approx. 18 metres, such an interpretation cannot be held credible. It was not a question of the lengths of the timbers but of the number of feet a man was capable of hewing in a day. At any rate Seidensticker realized that length measurements were under discussion. He also makes the affirmation that these quantities of wood, too, were termed 'loads,' though he in no way comments on this expression.

One of the oldest known orders concerning wood procurement is contained in a letter sent by Hammurabi (1728—1686 B.C.), the renowned law-giver, to a provincial governor. The letter contains a requisition for a total of 7,290 charcoal logs, conforming to exact measurements, that are to be delivered to the metal workers. The transportation to Babylon is to be carried out by ship in lots of 300 logs. It is specified that only green wood should be chosen for the purpose. The delivery was to be accomplished promptly so that the metal workers would not have to sit about idly (Griemerg II 1956, p. 60, Salonen 1965).
B. Skidding and transportation

Nowadays it is customary to make a dichotomy in respect of the transport of wood; on the one hand, forest or start hauling, which was previously called short-run hauling, and on the other hand, long-distance transport. In many cases such a division also suitably describes the transportation of timber in ancient times; but firewood, for example, was hauled in the earliest times directly from the forest to the place where it was used without changing the method of transportation. In the most primitive conditions even in the period of recorded history brute manpower was still used to do the work of hauling — nor has humanity in its entirety yet developed to the point where such things are not to be seen — but a rather early stage draft animals began to be used to carry small-sized wood, as has been mentioned above. Pictures of mules and asses carrying loads have been found in both the ruins of Egypt and the Fertile Crescent. The writer has not come across any picture pointing unequivocally to the transportation of wood. To my knowledge the earliest written information on the transportation of wood on the back of a beast of burden is in "the Iliads" (XIII 117—124, translated by G. Chapman).

But, when the fountful Ida's tops they scaled
With utmost haste,
All fell upon the high-hair'd oaks, and down their curled brows
Fell bustling to the earth; and up went all the boles and boughs
Bound to the mules; and back again they parted the harsh way
Amongst them through the tangling shrubs;
and long they thought the day
Till in the plain field all arrived, for all the woodmen bore
Logs on their necks; Meriones would have it so. The shore
At last they reach'd yet, and then down their carriages they cast,

The passage describes the preparation of a funeral pyre and due to the need for fire wood right away, men were also made to carry wood. The employment of men to transport wooden goods was quite common in connexion with military operations. Indeed, the soldiers in Caesar's legions when marching into unforested regions often trekked along for several days burdened with poles to be used in fortifications in addition to their other baggage.

If the person procuring the firewood was a self-employed seller of wood brought by him from the forest, he naturally strove to make the biggest loads possible. Thus, in Apuleius' novel, "The Golden Ass (Metamorphoses)," for example, the protagonist, bewitched into an ass whose fate it was to lend his back to the service of such a procurer of firewood, laments that the load which they tied on his back would have been better suited to the capacities of an elephant.

In Imperial Rome the network of roads was already so well developed (cf. Figs. 14 and 15) that even in the transport of firewood we can distinguish between start-hauling by animal back along the side of a road suitable for vehicles and long-distance transportation by animal-drawn waggons to the markets of large population centres. The last stretch of such long-distance transportation might even be along a paved road (paved road = via strata, from which, for instance, the word autotrarda is derived).

As for the transportation of large-sized timber in the forest, Virgil mentions in passing that ash trees were rolled down mountain slopes (adoleunt ingentis montibus ornos). The Bible tells (I Kings 5:8, 9) that the slaves (servantis, used in the Finnish O.T., is again an embellishment) of king Hiram of Tyre dragged the cedars for Solomon's temple from Lebanon to the seashore. The conception of Bible illustrator G. Donzé diverges rather sharply from the text, as will be seen in Fig. 16. Here we see teams of horses pulling the cedar logs. Besides being at variance with the text, this is factually incorrect because the horse is not known to have been used as a draft animal in ancient times. It was a noble animal that was used to pull royal carriages and war charriots, and, of course, it served as a mount. Oxen were used to pull heavy loads and asses or mules to pull lighter ones, but, as has been said, the Bible passage specifically mentions that slaves transported the wood for Solomon's temple. There is no information on the use

Fig. 14. Main highways of Italy in the second century A.D. (Singer et al. 1956, Markonen 1959 and 1960).

Fig. 15. Highway system of the Roman Empire in the second century A.D. (Singer et al. 1956, Markonen 1959 and 1960).

Fig. 16. Bible Illustrator's conception of the transport of Lebanon cedars.
of sets of wheels to facilitate the work of pulling. This may not be entirely improbable but it is not especially probable either. In the last analysis the transport of cedars was a small affair compared to the transport of mammoth boulders, monuments, etc., in ancient times. In Fig. 17 is seen a drawing made on the basis of a seventh century B.C. wall relief found in Sanherib's palace in Nineveh. Fig. 18 is a photograph of a relief portraying the same work. Both reliefs depict the transport of a gigantic monument in a sled drawn by a large gang of slaves. Logs are placed lengthwise under the sled and the logs over which the sled has passed are either carried or carted by the human labour force from the back of the sled to be placed in front of it again. According to Grimberg (1956) Sanherib used stone blocks weighing 30 tonnes to build his palace and because objects so large had not previously been transported in the Fertile Crescent, he had to figure out some means of transporting them. He evidently wanted to bequeath his procedure to posterity and so over 2600 years later we, too, have an opportunity to witness how the mentioned large-scale moving jobs were handled. Let us recall in passing that the largest stone blocks of the pyramid of Cheops weigh about 500 tonnes, that they were transported more than 100 kilometres, and furthermore, that some means was devised to get them to the upper parts of the pyramid.

The Bible illustrator's conception of the way a Lebanon cedar looks is also erroneous. The trees he depicts look like the diminutive remnants of the Lebanon cedars that are still found today. Because Lebanon cedars have been felled and transported to other lands ever since the third millennium before Christ, the best trees being continually selected, the Lebanon cedar has degenerated so much that its appearance has changed altogether. Originally, and surely still at the time when the temple at Jerusalem was being built 3000 years ago, the tree was of slender stem and relatively narrow crown, more like a good northern pine than an ancient park oak (Fig. 10 p. 17).

Saarisenko (1963) in his Companion to the Bible also calls the cedar a broad-branch tree, though he goes on to mention that the Tyrians fashioned masts from cedars (Isaiah 27:5). Suitability for masts is a clear indication of good stem shape and of low branchiness.

Sometimes large-scale construction projects were undertaken in the interest of wood transportation. Toward the middle of the first millennium before Christ, Nebuchadnezzar II began to rationalize the transportation of cedar from Lebanon. According to the cuneiform text he split sharp-peaked mountains, quarried stone blocks, opened passageways and built a slide for the cedars (Salonen 1945, p. 285).

Of the methods of transporting wood over long distances, floating (using flowing water to transport wood) and rafting (towing wood on the water) were certainly the oldest, and for a long time the only possible ways. According to Salonen (1945, p. 330), as far back as the third millennium B.C. the rulers of the Fertile Crescent boasted that they had brought Lebanon cedars from afar. Gudea, prince of the city of Lagash, who ruled round the year 2000 B.C., tells the following in his hymn on the building of a temple (Cylinder A. XV, translated into the German by Falkenstein and v. Soden):

Zum Zedernberg, in den kein Mensch eindringt, bahnte der Herr Ningirsu für Gudea den Weg. In die Zedern dort schlug der grosse Dachsel, zur scharf-Waffé, dem 'rechten Arm von Logasch', der Waffé, dem Orkan seines Königs, spaltete er sie mit dem Dachsel:

Wie eine grosse Schlange, die ins Wasser ..., ist sie.

Aus dem Zedernberg liess er Zedernbalken, aus dem zabalam-Berg liess er zabalam-Balken, grosse Tannen, Platanen, eranum-Stämme, grosse, übergrosse Balken daraus, um hohen 'Kai des Strahlenden Tores' (anlegen).
Now the passage speaks of logging at first and then of something that was (put?) into the water like a large snake. Salonen (see the above reference) has interpreted this as meaning that the wood was floated down river in rafts like a measureless snake. Further on the discussion is clearly about the loading on the wharf of the radiant gate of logs cut from various kinds of trees native to mountainous regions. In his paper on the history of wood transport by water, the Austrian Hafner (1955) has cited the older German translation of Thureau-Dangin according to which the last part of the passage given above runs as follows: "Aus dem Zederengebirge liess er Zedernflüsse, aus dem Zypressengebirge Zypressenflüsse... grosse übergrosse Flüsse daraus liess er am hehren Kai von Kasurra anlegen." Rafts are thus specifically mentioned here. In a later paper Hafner

(1961) has, however, also quoted the more recent Falkenstein and v. Soden translation which was mentioned above.

If the more recent interpretation has indeed decided on individual logs instead of rafts, it does not in the least render unlikely the possibility that the floating took place raftwise or bundlewise. In the upper left corner of Fig. 17 (p. 26) we plainly see, besides the basket-like guppur vessels, a bundle of logs lashed together with ropes, which the men are obviously steering downstream.

The previously-mentioned cedar logs procured for Solomon's temple were bound together in the sea to form rafts and then towed to the present-day Jaffa (2 Chronicles 2:16). This may be the first recorded case of rafting via a sea route. The kind of slobboat used is not mentioned but it could scarcely have been other than a multirowed vessel. Due to rough seas and the danger of storms, the rafts, which were towed one at a time, were probably not very large. The transport of cedar wood was arranged in the same way later on when the temple was rebuilt following the destruction of Jerusalem (Ezra 3:7).

The transport of wood as sea freight was not unknown in ancient times. The relief seen in Fig. 19, also from the palace of Sanherib, shows logs being towed behind the ships as well as being transported within them.

On the Tigris river a special type of raft called a kalakku, or nowadays, kelek raft, was used (Salonen 1945, pp. 345–348). Underneath the raft made of two or three layers of logs were fastened side by side lambskin sacks inflated with air; such a raft is seen in the upper left corner of Fig. 18. The same picture also reveals that these inflated sacks were used as such to enable one man to move about on the water. The kalakku raft had great carrying ability and it was also an otherwise suitable means of transportation on the rocky, shoal-infested upper reaches of the Tigris. Herodotus relates that the Assyrians constructed their kalakku rafts in the north, in Armenia, where wood was cheap, transported their goods to the south, where they dismantled the raft, sold the timbers of which it was made, loaded the emptied sacks on the backs of the asses they had brought with them and returned overland to Armenia to begin the cycle anew. This procedure which is also mentioned by Salonen, conveniently united the transport of wood with that of other goods.

Certain Roman writers make passing mention of the floating of timber. Vitruvius (Georgics II, 451–452) mentions the floating of wood down the P o River (nec non et torrentem undam levii innatat alnus missa Pado) and Pliny speaks of the floating of logs, and to some extent also of rafts, down the Tiber. According to Vitruvius, the larch was so heavy that it could not be floated by itself. It either had to be put on rafts made of fir or else transported by ship. Wood of this sort was, at any rate, transported from the slopes of the Alps along the Po all the way to Ravenna.
III. TIMBER TRADE

As was mentioned earlier (p. 27), the rulers of the Fertile Crescent had imported Lebanon cedars from far-away already in the third millennium before Christ. Certain price information, which does not relate to cedar, however, but to silver-fir, a material in great demand for shipbuilding, has been preserved from an equally remote period. During the third dynasty of Ur (about the turn of the third and second millennia) twenty silver-fir planks of an average length of about four metres could be purchased for one silver shekel (Salonen 1945, pp. 285—286). In the same period a kur of grain (approx. 250 l) also cost one silver shekel and unrefined bitumen or crude asphalt, for example, went for three-fourths shekels a tonne (Salonen 1945, pp. 174 and 253). Back then wood was very expensive compared with other goods. One silver shekel originally weighed 180 grains, or 8.4 g.

It should be observed in this connexion that forests have never grown in the Fertile Crescent. Formerly the bottom of the Persian Gulf, this region has gradually filled up with river sediment and has been put under cultivation in pace with the retreat of the sea. Thus from the very start wood had to be brought from far-away mountainous lands. Accordingly, the destruction of forests has nothing to do with the total degeneration of the Fertile Crescent — that ancient bread-bowl and cradle of culture — and its transformation into a land of death and silence; yet such a view has sometimes been held. The destruction has been caused by conquering peoples who sacked the cities, annihilated the whole population and thus caused the ancient network of irrigation ditches to fall into disrepair and ultimately deteriorate completely.

Dheimel (1925, p. 55) is of the opinion that one silver shekel originally was worth as much as the value of the yearly yield of one fully-grown date palm (Die Einheit des Geldpreises war also festgesetzt für die Vollwerte eines einzeln voll ausgewachsenen Baumes), according to Salonen (1945, p. 233) a full year’s yield was one kur in the best cases. Might it not be that the volume measure in question, which King Shulgi standardized as the “royal kur-measure” during the third dynasty of Ur (252, 6 l, Salonen 1966, p. 275), was originally obtained from the quantity of fruit that a date palm yields in a year?

Let us mention here that another weight measure that is still in use is connected with a certain tree; this measure is the carat used in the trade with gold and jewels. It is derived from the Greek word σκηρτόν meaning the pod of the carob-tree (Ceratonia siliqua). Σκηρτόν is in turn the diminutive of the word σκιρτς, meaning horn. The pods of the carob-tree resemble the spiral horns of certain animals belonging to the deer family, only they are much smaller; hence, the term. The seeds arranged transversely inside the pod are of amazingly equal weight when ripe and dry, and they were used in ancient times as weights in the trade dealing in jewels and gold. A precious stone’s value in carats thus originally indicated how many seeds of the carob-tree were equal to it in weight. One carat weighs about 200 mg. Later on the carat also came to indicate the gold content of an alloy, figuring as one twenty-fourth of the alloy’s weight.

One of the oldest known manifestations of the importation of various woods from abroad is probably the remains of a wooden chest that were found in an alabaster sarcophagus hard by the Saqqara pyramid in Egypt. These date from the period of the third dynasty (2775—2723 B.C.). It can plainly be seen from the remains of the chest (Fig. 20) that it was made of six-ply plywood. In every other veneer the grain runs perpendicular to the grain in the previous layer. Each layer is of a different kind of wood; and of these, it has been possible to identify with certainty cypress, Aleppo pine and Christ’s thorn (Zizyphus spina Christi). Two other conifer species are presumably the juniper and cedar. The sixth wood is unidentified at present. The veneers are held together with wooden pegs (Laurent-Täckholm 1951, pp. 274—275). Nothing new under the sun! Of the tree species mentioned, only Zizyphus, and possibly the still unidentified species, are domestic, the others being imported from abroad.

Trade in living trees has also been carried on for a very long time. History’s first prominent woman, Pharaoh Hatshepsut (fifteenth century B.C.), sent five ships to search for the legendary Land of Punt (presumably present-day Somaliland), which was held to be the homeland of the gods. The purpose of this voyage was to initiate trade with the inhabitants of Punt and top priority was given to getting living myrrh-trees (Boswellia adenodendron myrrha) to Egypt. And the expedition was a success. Punt was found and its inhabitants were friendly towards the visitors. The Egyptians had taken along
tity of cedar and cypress, the only existing information is that this was as much as Solomon desired. Indicative of the magnitude of the transaction is, among other things, the fact that in addition to Hiram’s slaves Lebanon had 10,000 of Solomon's tax labourers in its monthly employ.

Theophrastus also makes passing mention of wood trade. He says that the wood of a yew-tree from Arcadia is black or red but that of a yew from Mount Ida, yellow and like the wood of a prickly cedar (Juniperus oxycedrus) in appearance. Accordingly, merchants practiced deception and sold the last-mentioned tree as yew wood. Merchants have evidently had the same inclinations throughout the ages. In Finland, for example, much furniture of iroco wood (Chlorophora excelsa) has been sold as teak (Tectona grandis). In defense of the merchants it must, however, be said that iroco is not a bad wood, either.

Pliny, for his part, mentions that ash wood from Mount Ida looks so much like prickly cedar that purchasers can be misled by unscrupulous merchants. Pliny has apparently copied Theophrastus’ *History of Plants* very carelessly and made an error in translation. One could scarcely mistake a prickly cedar for an ash. The merchants are more tactfully characterized by Pliny than by Theophrastus, for the Roman seems to hang the responsibility for error round the neck of the purchaser.

According to Cato, it is advantageous to own farmland (aristum) in this context the word does not mean forest vineyard, in which meaning it was most often used by later writers) located on a farm in the vicinity of the city. So located, one can sell firewood and faggots and, furthermore, the farmer’s own need for wood gets satisfied. Cato surmises that willows from willow plantations established on such a farm will also sell well. On a farm farther from town, wood was not always in demand and in such a case Cato urges conversion of firewood to charcoal — in so far as on the farm there was no stone that could be made into quicklime — burning dead branches in the field and thereafter sowing poppy seeds. Valuable trees were also brought from far-away. The Bible accordingly mentions (Ezekiel 27:15) that Tyrus ruled over numerous distant islands from which, among other things, ivory and black wood (Diospyros melanoxylon) were brought to that city of commerce. Pliny knew that the Persians highly valued the currant tree (Hyphaene Thebaica), which grows in Egypt, for the waveliness of its grain, so that it was apparently exported from Egypt to Persia. The same source tells that an unidentified bratus-tree, which resembled the cypress, was imported to Arabia from the province of Lycia (in present-day western Iran) to be used as cense. A tree called the stobrus, also unidentified, was imported from Carmania (present-day Pakistan) for the same purpose; this when burned gave off a pleasing odour but caused head-ache. It was notwithstanding used as a sleep-inducing medicine for the ill.

In Chapter 19 (De actionibus empi venditii) of the part of the anthology Corpus Iuris Civilis entitled *Digesta*, Ulpianus, barrister at law, is accredited with the opinion that if moveable property be sold along with a farm, then fallen trees, coal, and other things of the sort are grouped as moveable property. Trees could thus be sold by the whole trunk.

Because wood has everywhere served principally as a fuel, special selling places for firewood have presumably sprung up in population centres at a very early stage. In Rome such a wood-mongers’ street (inter lignarios) was located near the Porta Trigeminia on the south side of town at the side of the road leading to Ostia. Livy mentions this offhand in connexion with an entirely different matter.

A great help to the transport of wood were the roads built and paved by the Romans, and wholesale dealers (lignarius negotiator) began to appear on the wood-trading scene. No information has been preserved on the price of firewood bought in the wood markets of the cities, but it probably gradually stabilized at a high level. Pliny already talks of saving firewood (compendium ligni). Referring back all the way to the time of Cato, Pliny mentions that the most popular vegetables were those which did not require cooking, thus economizing on firewood. One of Horace’s epistle letters reveals that in the countryside, too, already in the very earliest times a pedestrian wanting to warm up his food on a cold night had to buy firewood. When discussing the preparation of bronze,
Pliny speaks of the lack of firewood in many parts of Italy and also in the provinces.

Regarding the prices forest owners got for wood, a couple of facts have been preserved. Pliny mentions that poles and staves made of twelve-year-old cypresses went for the price of one denar each, that cypress is the most productive plantation of all and that people in bygone times called such plantations "daughters' dowries." Columella is probably the only ancient writer to have said something about the annual yield of a forest, though, to be sure, without specifying what kind of forest was in question. He observes that meadows, pastures and forests (prata et pascua et silvae) seem to be taking good care of their owners if they annually produce 100 sesterces to the Roman acre (agrum, about 0.25 ha.). According to Strabo's Latin-Finnish dictionary, one sesterce was worth about twenty Finnish pennies in the early 1930's; taking into account the change in the index of the cost of living and the changeover to the new mark, this would now be about eight Finnish pennies. Since one denar = four sesterces, one cypress pole would thus have cost 32 pennies. Since one ha. = four Roman acres, the annual of a forest would have been thirty-two Finnish marks to the hectare. In Finland in the first half of the 1960's the average annual gross income from farm forests was estimated at fifty-eight to the hectare. Comparing a two thousand-year-old monetary value with its present-day equivalent is, however, probably more or less of a numerical diversion having no mentionable basis in fact.

In telling about especially large trees known in his own time, part of which he had seen himself, Pliny mentions a ship presumed to be the largest to have ever sailed the seas up till then; namely, the ship by which the obelisk was brought to Rome from Egypt at the command of emperor Galus. This obelisk was then erected at the Vatican Circus. The mast of the ship mentioned was a fir the circumference of which was four times the length of a man's extended arms (most likely measured at deck level). Thereafter Pliny says that in general it is told that masts for such purposes are sold for 80,000 sesterces and even more. For the binding of such trees to form rafts for water transport even sums in excess of 40,000 sesterces were paid. There is no information on the size of these rafts.

Wood transportation and trade were probably relatively lucrative business endeavours in ancient times. Strabo relates that there lived in Mylasa in Asia Minor a well-known orator named Hybleas, who, inheriting from his father, likewise a well-known orator, nothing more than a mule trained to carry firewood and the mule's driver (a slave), supported himself and paid for his studies in Antioch with the income this mule enabled him to earn until he eventually returned to his home land and assumed the position of aedile.

IV. THE PROCUREMENT AND TRADE OF OTHER FOREST PRODUCTS

A. Bark

Tree bark has been used for many purposes ever since the earliest times. In exceptional circumstances, for example, when war has caused a dire scarcity of food, raw bark has served to fortify man even in relatively high-level cultures. Herodotus mentions ancient Greece as a case in point. Primitive peoples have continuously used tree bark as a source of nourishment. According to Arrian, certain tribes in India, for example, ate the bark of the talo-tree (a species of fan-palm). Bark was also eaten by the Indian soothsayers (ol oogarutul), who belonged to the first caste. Bark for consumption, however, has probably never been a trade commodity. In any event, no mention of such activity is to be found in ancient written sources. On the other hand, bark that served as the basic ingredient of spices, for instance, the bark of the cinnamon-tree (Cinnamomum cassia), was the object of a vigorous trade even in antiquity. The Bible, too, mentions cinnamon and wild cinnamon or cassia as the ingredient of a fragrant ointment (Exodus 30:23–25).

Before the introduction of papyrus and even after its use became widespread, writing was done on bast fibre. One of the authors who makes mention of this is Quintus Curtius Rufus. In fact the Latin word liber, which originally meant bast fibre, later came to mean book for the very reason that bast fibre was one of the first writing materials. A similar semantic shift is illustrated by the word caudex (codex). Prior to the introduction of papyrus, writing was also done on waxed boards which were combined to form books. Since these boards were prepared from thick sections of trunk (caudex = trunk), people began to use the term caudex, later codex, to indicate the books made from such boards. Subsequently this term came to indicate old manuscripts and, ultimately, collected works written or printed on parchment or paper.

Ever since very early times the bark of the lime-tree has been used for making rope and weaving baskets. The bast fibre of other trees, too, has been exploited for making such things as sails, rugs and blankets. Due to the multiplicity of the uses of bast, it was apparently a trade item in the ancient world, though no direct mention is made of this in ancient sources.

We might mention as a curious sidetone that according to Arrian the Gordion knot which Alexander the Great severed with his sword was made from the bark of the cornelian cherry (Cornus mas). The ichthyophaghs of India (a fish-eating tribe) wove their nets from twisted thread made from the bark of the date-palm. The bark of the elder, sumach and Aleppo pine was used in dying and tanning leather. Theophrastus has supplied us with this information and Pliny repeats it in his «Natural History». Trade in barks used for tanning was apparently engaged in at a very early stage, though the writer has not come across a direct reference to this.

Particularly deserving of mention is the procurement and trade of cork. It seems a trifle surprising that Virgil mentions cork as the material of the helmets of the ancient Italic peoples (Aeneid VII. 742: legum quae capitum rapuit subere cortex). This is, however, the only mention of the effect. Cork has been widely used to stopples wine jars ever since ancient times, and the same applies to its use as a fishing float.

It remains to say something about birch bark, though one would think that this does not pertain to ancient forestry. Indeed, the birch was a tree species so completely unknown to the ancient world that none of the great languages of the time had a word for it. The modern scientific name for birch, betula, which Pliny is the only ancient writer to mention, is a word of Celtic origin. It thus seems apparent that the birch was unknown to the Romans until they penetrated
sticks, to name a few. To be sure, LAURENT-TÄCKHOLM observes that to an inhabitant of the Nordic countries it seems as though Tutankhamen had an especial fancy for birch bark. It is surprising that DESROCHES-NOBLECOEURT in his work *Vie et mort d'un pharaon Toutankhamon* does not mention birch bark at all, though he carefully describes the ornamentation of the objects found in Tutankhamen's tomb. In Pharaoh's opinion birch bark was apparently as rare as gold and jewels and its importation into Egypt was probably a very difficult matter. It has thus far not been possible to explain where the birch bark that found its way into Egypt at such an early date has come from and by what route. In addition, birch bark has been found in Stone Age dwellings — over 7000 years old — in the Fajum desert in Egypt (LAURENT-TÄCKHOLM 1951, p. 95). It is difficult to imagine that at such an early date there were trade contacts with, say, Asia Minor, where birch occurs naturally in the north. The question has yet to be solved.

B. Fruits

It goes without saying that all kinds of edible fruits, berries and nuts have been sought after throughout the ages, and they have usually also been trade items. Indeed, all fruit farming has begun with native plants. In the first chapter of Genesis (1:29) this is stated as follows: *And God said, Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree, in the which is the fruit of a tree yielding seed; to you it shall be for meat.*

As for the date-palm, fig-tree and olive-tree, for example, we can say that these fruit trees have been cultivated since the beginning of human history. As mentioned in the preceding chapter, the annual yield of the date palm formed the basis of one of the earliest units of volume and money. HOMER describes the wondrous properties of lotus berries most eloquently (Odyssey 9.92–97, translated by Geo. Chapman):

Wrote the Lotusbs, that made them eat, Their country-diet, and no ill intent Hid in their hearts to them; and yet th' event To ill converted it, for, having eat Their dainty viands, they did quite forget As all men else that did but taste their feast Both countrymen and country, nor addrest Any return 'Inform what sort of men Made fix'd abode there; but would needs maintain Above themselves there, and eat that food ever.

HECTORATUS (IV. 177) and THEOPHRASTUS (IV. 3.1) both mention lotophagi or lotus eaters.

Let us now return to a point mentioned in the first part of this study (MARKONEN 1967, pp. 52–54). The holy shoaḥ-tree of the ancient Egyptians, which in Greek and Roman literature is called the *persea* and which the Arabs later called the *lebbakh*, finally disappeared altogether from Egypt and thereafter no-one any longer knew to what tree these names had referred. It was, however, possible to identify this tree as *Minusops Schimperi* on the ground that it grows in Arabia, where this tree still grows in natural state, the old Arabic name for its fruit, *lebbakh*, is still current. On one of his travels in Arabia SCHWEINFURTH, the well-known specialist in the botany of ancient Egypt, once saw the fruit of the *minusops*-tree being sold in the market place of a small village. Upon inquiring what the name of this fruit was, he received the answer *sebbaks*. SCHWEINFURTH says that he was entirely unaware of the fact that the fruit of the *minusops*-tree was edible. The delectableness of the fruit of the *persea*-tree was, however, known already in antiquity. This is mentioned by STRABO, among others.19

Deserving of mention as an example of natural fruit tree abundance are the landward slopes of the legendary Atlas mountains. Here fruits of all description flourished in such abundance that, as PLINY puts it so eloquently 20, the desire to eat was never unaccompanied by the possibility of satisfaction. The use for nourishment of several fruits, berries, nuts and acorns known nowadays is mentioned in ancient times. Only citrus fruits appear to have been more or less unknown. In Greek there was no word at all for the

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Fig. 22. "Boomerangs" decorated with birch bark, found in the tomb of Tutankhamen. These artifacts probably served as symbols in some sort of religious rite (LAURENT-TÄCKHOLM 1951).
citron, but the word citron-tree does in fact occur in a Latin-derived form in the Greek text of the *Geoponica*, an ancient anthology of writings on agriculture which the emperor of the east, Constantine VII Porphyrogennetos, who was interested in the arts and sciences, finally had compiled in the ninth century. As early as the first century the citron was to some extent known to the Romans but even then Pliny is the only one to make a few references to it. The word *citrus* is indeed to be encountered in the works of a few other Roman writers at a considerably earlier date; however, the reference is not to the citrus-tree but to a tree named *Callicirus quadriviolatus*. The orange was apparently totally unknown in antiquity.

C. Dendrous fluids

Different fluids that flow from trees after breaking of the bark were used for many purposes in antiquity. Resin of great value was obtained from the terebinth (*Pistacia terebinthus*). To Pliny's knowledge the light resin of the mastich-tree (*Pistacia lentiscus*), which was native to the island of Chios, was the most well-known of all and cost ten denars a pound (Roman pound = 327 g.) Dark mastich, on the other hand, cost only two denars a pound. Other resinous fluids and other materials found after that were usually used for preparing incense and salves were obtained from such trees as the myrrh (*Balsamodendron myrrha*), the storax (*Storax officinalis*), the balsam (*Balsamo- dendron pumilum*) and the frankincense tree (*Boswellia Carteri*). These products are mentioned quite frequently in the literature of ancient times and they also gave rise to a vigorous trading activity. In the Bible, too, they are mentioned in many connections.

The use of cedar oil in the embalming of bodies is deserving of especial mention. One of the writers to describe this is *Herodotus*. The resin of other coniferous trees was also collected on a large scale. As an example of the way in which these resins were employed we might mention the use of the resin of the stone pine (*Pinus pinea*) to flavour wine. This custom, which arose from the fact that the resin was believed to be an aid in storing wine, has been preserved right up to modern times. Even today Greek *Retsina* wine, which is flavoured with resin, is well-known in international trade circles.

Regarded from the viewpoint of the Nordic countries, it is interesting that tar burning was practised in Macedonia as early as the fourth century B.C. In the very same way as it was practised in the Nordic countries right up to the present century. Let us turn the discussion over to our old peripatetic friend Theophrastus: 'This is the manner in which they make pitch by fire: — having prepared a level piece of ground, which they make like a threshing-floor with a slope for the pitch to run towards the middle, and having made it smooth, they cleave the logs and place them in an arrangement like that used by charcoal-burners, except that there is no pit; but the billets are set upright against one another, so that the pile goes on growing in height according to the number used. (Here there seems to be a difference in comparison with the method used in the Nordic countries, where the resinous billets are stacked in an overlapping fashion such that they point to the centre of the tar pit, i.e. the opening out which the tar is to flow.) And they say that the erection is complete, when the pile is 180 cubits in circumference, and fifty, or at most sixty, in height; or again when it is a hundred cubits in circumference and a hundred in height, if the wood happens to be rich in pitch. Having then thus arranged the pile and having covered it in with timber they throw on earth and completely cover it, so that the fire may not by any means show through; for, if this happens, the pitch is ruined. Then they kindle the pile where the passage is left, and then, having filled that part up too with the timber and piled on earth, they mount a ladder and watch wherever they see the smoke pushing its way out, and keep on piling on the earth, so that the fire may not even show itself. And a conduit is prepared for the pitch right through the pile, so that it may flow into a hole about fifteen cubits off, and the pitch as it flows out is now cold to the touch. The pile burns for nearly two days and nights; for on the second day before sunset it has burnt itself out and the pile has fallen in; for this occurs, if the pitch is no longer flowing. All this time they keep watch and do not go to rest, in case the fire should come through; and they offer sacrifice and keep holiday, praying that the pitch may be abundant and good. Such is the manner in which the people of Macedonia make pitch by fire.'

The great size of these ancient tar pits have died of mushroom poisoning. Emperor Nero's prefect Annaeus Serenus was one to suffer such a fate along with his tribunes and head centurians. Indeed, Pliny exclaims: 'What can be the great enjoyment of eating such a dangerous food?' Pliny also makes separate mention of mushrooms that grow on trees. He was acquainted with, for example, coryx fungus (polypore) from which tinder was made for making fire was obtained. He uses the name *fagus arida* (dry mushroom) for this species. Certain mushrooms growing on trees were also fit to be eaten. Pliny tells that there are three species of poplar, the abele (*Populus alba*), black poplar (*P. nigra*) and Libykan poplar (apparently a local strain of the black poplar), which have very small and dark leaves which are famous for the mushrooms that grow on them. In Gaul there occurred in the crowns of oaks a pungent white mushroom (*agricium*) which was an effective antidote (for mushroom poisoning, snake bite?). This mushroom shone in the dark and for this reason it was gathered at night.

D. Mushrooms

In the oldest written sources mushrooms are not mentioned at all. It is not until we come to Greek literature that we find some references to them. Aristotle mentions three species of mushroom (*empyrea*) but classifies them along with animal life. Theophrastus considers them to be clearly plants but an especial case in that they totally lack roots. Theophrastus makes no comment about the use of these mushrooms as food or about their possible value as trade commodities. Neverthless, he knew of such species as the truffle (*Truffles*) and cap mushroom (*Morchella*).

The Romans at any rate held the mushroom in high esteem. However, detailed information about mushrooms, including their use as food, is primarily limited to the writings of Pliny. He relates, for example, that at the dinner table praeproetor Larlius Licinius broke his front teeth while eagerly chowing a truffle into which a dinar that had been dropped on the ground had chanced to find its way. Pliny also speaks of the poisonousness of mushrooms and tells that whole families along with their table guests

E. Leaves

Leaves have served man's needs for as long as his history is known. Let us only mention the use of palm leaves in rope making and as a thatching material. Potions concocted from the leaves and needles of many trees were used for medicinal purposes; for example, a drug obtained from fir and juniper needles by cooking them in vinegar was used against toothache. Leaves have been widely used as food for grazing animals, especially during seasons when there was no fresh grass, for example, during a hot, dry summer period.
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I. EUSEBIUS, Works and Days 420–422: Τίμων ἔργα ἁγνά, τόμος ἑπτάθυμον, τούτοις φύλλα ἡ ἐργαζ ἑστήκε, στούρβω τε λίγης τίμιος ἐν ἑλατούμενοι μεγίστο ἄρα 

II. THEOPHRASTUS, HP V.1.1: Οἱ χρόνοι δὲ τῆς κέρας ὕλης καὶ ἔκρυς ἐπὶ τῆς ἄλοιπης τῶν πλευρῶν καὶ ἐκστικητὰ, δὲ τὰ ἀναλλοίωτα αἰφνιδίως ἄναπληκτὰ καὶ ἑξέρχοντα. 

III. THEOPHRASTUS, HP V.1.2: δέκα δὲ ἐργαλεῖα καθαρίσμος μετὰ τοῦ μετάφυσιν, ὡς ἐν ὑποστήριγμα τῆς ἀκρόπλακτης δύναμις, καὶ ἀπὸ τῆς ἀπορίας τῆς καθαρότητος τοῦ καθάρου 

IV. CATO, Rust. V.16: Quae materies secundo habent murum habebant, tempestiva est. Quae materies secundo habebant, cum globulit, tum tempestiva erant. 

V. Cato, Rust. XXXII.1: Ulmæum, pineum, ne calemar, anthis alici materiam omnem cum effoditis, luna decretibus lunamini post meridianim sine vento autoribus. 

VI. PLINY, NH XVI.60: 158: titus et quibus auterum securis corumbam a bruma ad favoritum, sit praeverens cognoscer, aurarii occasum et ante eum etiam propinavisse ratione solutio: desideris hulfam redurrem su loco. 

VII. PLINY, NH XVI.190–191: Infinitum refer et neque tanta, cum magnis carnis magno etiam nucibus, sibi certe Tiberius Caesar concreato ponte nauchamocris lauries ad restituendum caedem in Raetia praebuit, quia de caedibus etiam erat illa loca, quod fieri potest nisi noopto, qui competent aliquod magnis dieum brumae eum, illa futuris materias. 

VIII. PLINY, NH XVI.81: 230: ethis autem murum, necque, nec sequens cæsariae quam immutare, quippe cum ex olea, dulcis risino, gardium in foribus dittius immorti plantarium. 

IX. STRABO, X.1.46: Μετά γὰρ τῶν θερματικῶν καὶ τῶν τομῆς τέρματον φυσικὸν εἶναι μέτριον ἡμέρας τε καὶ ὁμολογίας τῆς. euclis vehit 

X. Aelian, Inde 24.9: τοῖς γάρ δὲ ἄνθρωποι ἄνθρωπος ἀνθρώπου ἀνθρώπων ζώον, οὐ πόσον μένος ἔνωσεν ἀνθρώπων — ἀνθρώπων για τάκτων αὐτῶν τότε. 

XI. THEOPHRASTUS, HP V.1.1: τὰ χρόνια ἐκ τῆς λιθινῆς δομῆς κέρας ἐκτίθεσθαι διὰ τὸ ἀποκλείει ὑπάρξει τῆς σωμάτων καὶ ἐξοντώσει τῆς πλευρᾶς καὶ ἐκφεύγει, δὲ τὸ παρακεῖτον ἀλλοῦ τῶν ἄλλων καὶ ἔξωρθη 

XII. PLINY, NH XVI.133: 227: aedii enim latiis que muris, talemqueque murum, etiam praeter robur et luxum pertinaciam resistunt serrarumque dentes repellent accentuat inertia, quae de causa alterna inclinatione egerunt. 


XIV. PALLADAS I.42: serralae manubrietatee mi. mores maioresque ad mensuram cubiti, quibus facile est, quod per serram fieri non potest, resceduco trunco artus, aut visi vertes. 

XV. PLINY, NH XVIII.16: hiereor sanguini tanta vis est, ut ferentorum subtilissimas non aliter aceribus induriet, scabriola poliatur ve- 

XVI. PALLADAS XII.16: Hoc mense locis siccis, calidis et apropri maiores artes transversum truncantis ramis, illeis radipitet, multo stercoru et rigationibus aviusdum. 

XVII. COLEMMULA, Rust. XII.11: 2: Palma una opera cadere et expugnare acerum centum numer potest: ridicae autem quenues, sive oleaginis findere, etiam his parte exacere numero sexaginta. Item ad incubationem ves- pertinam palos decem vel ridica quoniam con- 

XVIII. VARRO, Rust. XX.3: 3: Aestete fieri messes operis publici, autem a tecti auxilia, non nec sequentibus si quis producit caudam esse, et sequentibus cum eth no- 

XIX. PLINY, NH XVIII.233: 232–233: reilqua opera nostra maxima etiam est, cum sint noxias tantum ampliores, quales, crates, 

XX. COLEMMULA, Rust. XII.13: 1: Materies si roboreas est, ab uno fabro doliari ad unquam per quadratum centum esse retenti. et ipsa die suam vehit. 

XXI. COLEMMULA, Rust. XII.13: 1: Materies si roboreas est, ab uno fabro doliari ad unquam per quadratum centum esse retenti. et ipsa die suam vehit. 

XXII. COLEMMULA, Rust. XII.13: 1: Materies si roboreas est, ab uno fabro doliari ad unquam per quadratum centum esse retenti.
maxime necessarii. qui clavo vel altero lapide percussi scintillam edunt quae excepta sulphure aut fungis aridis vel foliis dicto celerius praebet ignem.

IV 25. Pliny, NH XVI. xxxv. 85: populi tria genera, alba ac nigra et quae Libya appellatur minima folio ac nigerrima fungisque enascen
tibus laudatissima.

IV 26. Pliny, NH XVI. xiii. 33: Galliarum glan
diferarum maxime arbores agaricam ferunt; est au
tem fungus candidus, odoratus, antidotis efficax,
in summis arboribus nascens, nocte relucens: signum hoc eius quo in tenebris decipitur.

IV 27. Pliny, NH XXIV. xix. 28: Piceae et laris
colla trilla et in acetum decocta dentium dolori prospunt. — —

IV 28. Columella, Rust. XI. ii. 48: Pabulum, si
facultas est, vel nunc vel etiam superioribus XV
diebus, qui fuerunt ante calen. Iunii pecori prae
eri oportet. A cal. autem Ianuis, si iam deficit
viridis herba, usque in ultimum Autumnnum
frondem caesam praebebimus.
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Lycopodium clavatum L.- ja L. annotinum L.-kasvustojen laajuus rinnastettuna samanpaikkaisiin L. complanatum L.- ja Pteridium aquilinum (L.) Kuhn -esintymiin sekä puuston ikää ja paloaikoihin. Summary: The Size of Lycopodium clavatum L. and L. annotinum L. Stands as Compared to L. complanatum L. and Pteridium aquilinum (L.) Kuhn Stands, the Age of the Tree Stands and the Dates of the Fire, on the Site.


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Beschreibung des Wachstums der Bäume als Funktion ihres Alters.

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Kuusen ja männyn kasvun kehitys ojitetuilla turvemaililla. Summary: Post-Drainage Growth Rate of Norway Spruce and Scots Pine on Peat.

Biological Activity in Some Natural and Drained Peat soils with Special Reference to Oxidation-Reduction Conditions.
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