

ACTA FORESTALIA FENNICA

Vol. 95, 1969

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

Olli Makkonen



SUOMEN METSÄTIETEELLINEN SEURA

Suomen Metsätieteellisen Seuran julkaisusarjat

ACTA FORESTALIA FENNICA. Sisältää etupäässä Suomen metsätaloutta ja sen perusteita käsitteleviä tieteellisiä tutkimuksia. Ilmestyy epäsäännöllisin väliajoin niteinä, joista kukin käsittää yhden tutkimuksen.

SILVA FENNICA. Sisältää etupäässä Suomen metsätaloutta ja sen perusteita käsitteleviä kirjoitelmia ja lyhyehköjä tutkimuksia. Ilmestyy neljästi vuodessa.

Tilaukset ja julkaisuja koskevat tiedustelut osoitetaan Seuran kirjastolle, Unioninkatu 40 B, Helsinki 17.

Publications of the Society of Forestry in Finland

ACTA FORESTALIA FENNICA. Contains scientific treatises mainly dealing with Finnish forestry and its foundations. The volumes, which appear at irregular intervals, contain one treatise each.

SILVA FENNICA. Contains essays and short investigations mainly on Finnish forestry and its foundations. Published four times annually.

Orders for back issues of the publications of the Society, subscriptions, and exchange inquiries can be addressed to the Library: Unioninkatu 40 B, Helsinki 17, Finland.

ANCIENT FORESTRY AN HISTORICAL STUDY

PART II

THE PROCUREMENT AND TRADE OF FOREST PRODUCTS

OLLI MAKKONEN

Motto:

Ferrarii, lignarii, doliorum
cuparumque factores necessario
habendi sunt, ne a labore
solenni rusticos 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 IIRO KAJANTO, Assistant Professor PÄIVÖ OKSALA, 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 VEIJO HEISKANEN, KULLERVO KUUSELA, SAKARI SAARNIJOKI, 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

CONTENTS

	Page
Preface	3
Contents	4
I. Introduction	5
A. General information	5
B. The most important ancient written sources from the standpoint of the procurement and trade of forest products	5
C. Related modern literature	6
D. Formal considerations	7
II. Logging and transportation	8
A. Felling and primary conversion	8
B. Skidding and transportation	24
III. Timber trade	30
IV. The procurement and trade of other forest products	35
A. Bark	35
B. Fruits	37
C. Dendrous fluids	38
D. Mushrooms	39
E. Leaves	39
Bibliography	40
References in the original	43

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

MODERATUS COLUMELLA, is also a frequently used source in this part of the study.

We shall make several references to the agricultural calendar (*De re rustica*) of PALLADIUS RUTILIUS TAURUS AEMILIANUS (fifth century A.D.). Although PALLADIUS is not among the most important sources for this part of the study, it is from him that we have chosen the motto on the title page: «There must necessarily be smiths, woodworkers and makers of barrels and wooden vessels so that yearning for the city would not entice country folk away from their traditional work.» This thought is as timely as ever and holds true for present-day Finland as well as other lands. It most clearly reflects the problem of rural handicraft and small industries as well as the population shift from rural areas to the cities. Again, it seems, history repeats itself.

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.

DEIMEL's (1925) study «*Die altsumerische Baumwirtschaft*» contains interesting information concerning the fact that the annual yield

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 connexion 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 Iustinianus*», a collection of imperial laws from the second to the sixth century A.D. and 4. «*Novellae*», containing most of the laws of emperor Justinian's time.

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 kännedomen 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. ARO (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 Babylonien nach sumerisch-akkadischen Quellen*» (1939) and «*Kaksoisvirranmaa*» (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 II: 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 RUBNER's 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.¹ 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-appearing 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.² 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.³

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.⁴ 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 waning and that the south wind should not be blowing at the time.⁵

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.⁶ 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 *pons naumachiarius*, 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.⁷

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.⁸ 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 1950's the writer 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 29:10, 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, chaptains 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 depreciation 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.

HIERONYMUS, 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 caesoribus, et his qui comportant aquas*), an interpretation nowadays held incorrect. This may, 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 STRABO's report is reliable. To his knowledge there were seven casts in India, manual labourers (*οἱς ἀπὸ τοῦ οὐματος ἡ ἐργασία*) belonging to the fourth cast along with artists and small merchants.⁹

Forest workers seem to have been made up of both slaves and free wage earners. The people of Gibeon who in the above-cited passage from the Book of Joshua were cursed and condemned to slavery were notwithstanding pardoned and made «the woodcutters and water-carriers of the congregation and of the Lord's altar», which is to say that they were given a specific task yet remained 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 (DEVÈZE 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 unemployment and crudity are its consequences.» Not until this century, or more precisely, not until recent times have wood-choppers, 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 *ὄρεσιόπος* (mountain woodsman) and *ὑλοτόμος* (wood-cutter, wood craftsman). The last-mentioned word also occurs in «The Iliad» and in the works of HESIOD. To indicate a worker who only felled trees SOPHOCLES uses the term *δενδροτόμος* (cutter of erect trees, tree-feller). In the Greek version of the Old Testament a woodsman is called *ξύλοποιος*. All these words embody the meaning, to cut, to chop (*κόπτειν, τέμνειν, κόπτειν*). 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-work» and «wood-cutter». 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: *qui lapides caedunt, lapicidas dici, qui ligna, lignicidas non dici*). The term *lignator*, which meant woodsman 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 woodsman 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 straightaway 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 caesor* (same meaning) are used. It could very well be that the verb, *caedere*, which originally meant to chop, to strike, took on the additional signification of felling for the very reason that trees were felled with an 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 sprig 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 harder stone 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 lake 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 4 000 years (RUSSELL 1967, p. 41).

Even well into the period of recorded history the axe (Gr. *ἀξίση, πέλεκυς*, Lat. *ascia, securis*) 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:

δῶκεν οἱ πέλεκυν μέγαν, ἄρμενον ἐν παλάμῃσι,
χάλκεον, ἀμφοτέρωθεν ἀκαχμένον· αὐτὰρ ἐν αὐτῷ
στειλεῖόν περικαλλῆς ἐλάϊνον, εὖ ἐναγρήδός.

Copper is mentioned as the material of the axe-head and, indeed, the events of the 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 indicating the material of the head, *ferrum* (iron). Iron 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

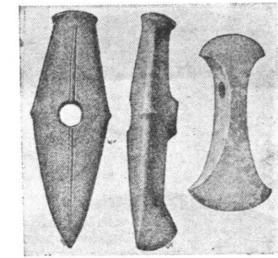


Fig. 1. Stone Age Axes.

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 Casandria 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, ARRIAN (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.¹⁰

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 slain the Minotaur. PLINY's contemporary, LUCIUS ANNAEUS SENECA, also mentions Daedalus as the inventor of the saw. The Athenian APOLLONORUS, who



Fig. 2. Clearing a field for planting in ancient Egypt. Picture from a tomb in Thebes, ca. 1420 B.C. (SINGER et al. 1956).

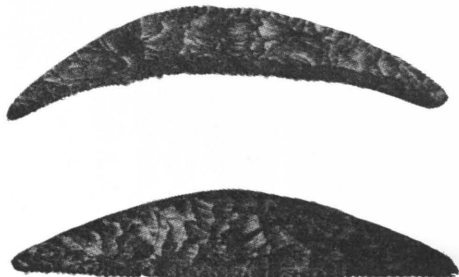


Fig. 3. Flint saws from Skåne, Sweden (NÄSLUND 1937, ARO 1945).

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 «Bibliotheca» — 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 IULIUS HYGINUS, also a contemporary of Augustus, as well as PUBLIUS OVIDIUS NASO (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 PERDIX 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 spinas in pisce notatus
trahit in exemplum, ferroque incidit acuto
perpetuos dentes, et serrae repperit usum.*

All Roman sources tell of the invention of the iron saw, though, in fact, the references from Greek mythology, in 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 NÄSLUND (1937) in his work on the history of saws entitled «Sågar», 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



Fig. 4. Daedalus holding the saw with which he fashioned a wooden cow for Minos' wife, Pasiphae. Relief in the Palazzo Spada, Rome (*Holz-Zentralblatt* 22. 12. 1961, *Bellage*).

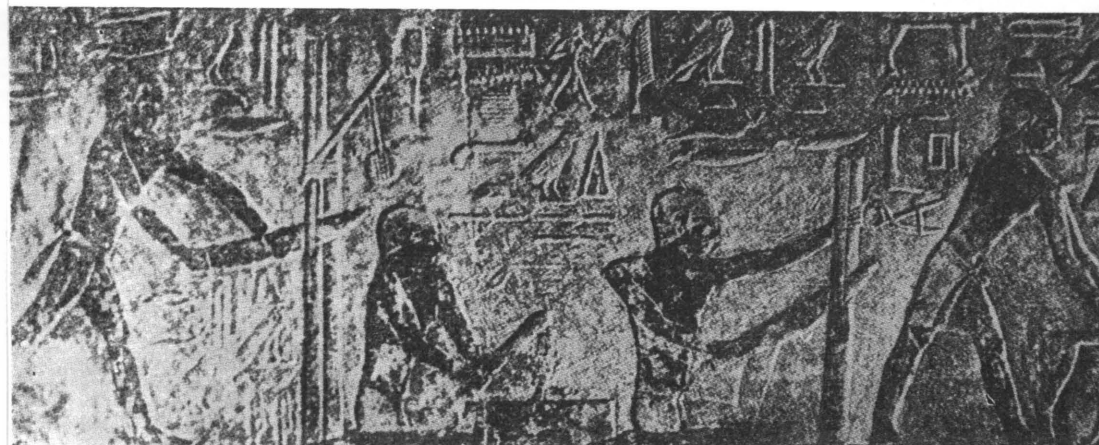


Fig. 5. Egyptian carpenters. Relief from the sepulchre of Ti, ca. 2700 B.C. (FELDHAUS 1931, NÄSLUND 1937, ARO 1945, MAKRONEN 1959 and 1960).

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 (2980—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 T i. Fig. 5 shows a detail from these reliefs. It has been taken from FELDHAUS'S (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'S (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. NÄSLUND (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

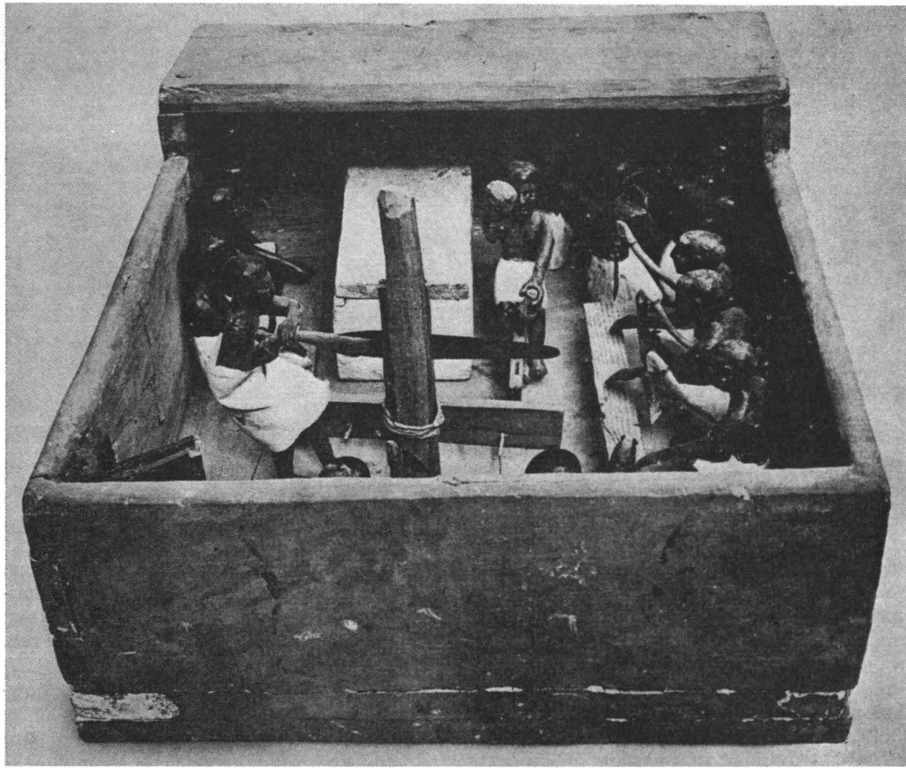


Fig. 6. A miniature model of a carpenter's workshop, found in the tomb of Pharaoh Mektetre, 11th dynasty, ca. 2000 B.C. (LAURENT-TÄCKHOLM 1951).

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

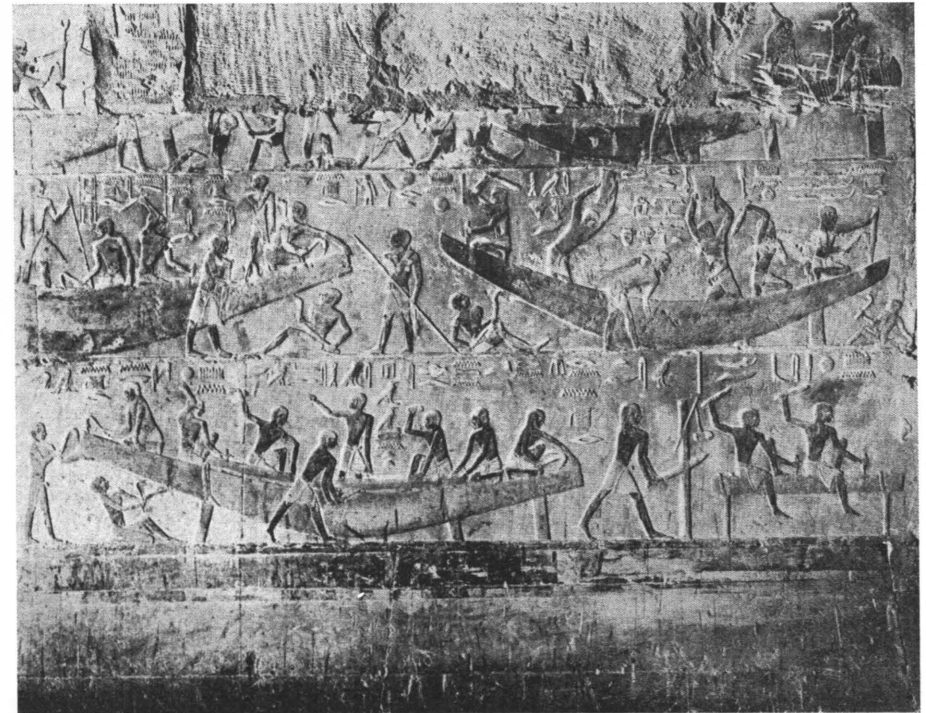


Fig. 7. Egyptian shipwrights. Relief from the same place as Fig. 5 (SALONEN 1939).

order to get rid of the sawdust.¹¹ A similar reference by PLINY is found in Roman literature.¹²

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. *πλοῦν*, 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

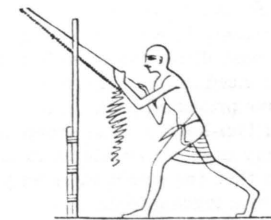


Fig. 8. Man sawing a board lengthwise. The picture, which is drawn on a sculptural work, is from Thebes in Egypt 1600—1100 B.C. (WILKINSON, 1854 NÄSLUND 1937, MARKONEN 1959, 1960 and 1966).



Fig. 9. Assyrian tools. Relief dating from the 7th century B.C. (A.-B. Stridsberg & Björks katalog 1931, NÄSLUND 1937, MAKKONEN 1959, 1960 and 1966).

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 unframed 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. *lima*) was indeed known but it was probably not very efficient because as far as PLINY knew, a he-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



Fig. 10. Lydians felling Lebanon cedars (BEEKMAN 1949, MAKKONEN 1967).

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 Rautalampi 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

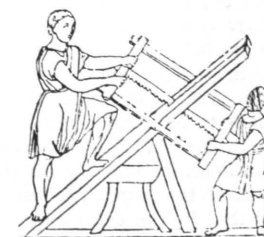


Fig. 11. Sawing a plank lengthwise with a frame saw. Picture from an Etruscan vase (RÜHLMANN 1865, NÄSLUND 1937, ARO 1945, MAKKONEN 1959, 1960 and 1966).

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 to be cut into lengths 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 cormorant and the bittern shall possess it; the owl also and the raven shall dwell in it; and he shall stretch out 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 44:13: »The carpenter stretcheth out his rule; he marketh it out with a line; he fitteth it with planes, and he marketh it out with the compass, and maketh it after the figure of a man, according to beauty of a man; that it may remain in the house.» Rather far-reaching conclusions have been drawn on the basis of these figurative utterances.

We may here well remark that in Northern Europe — but not elsewhere — there is a term connected with wood measurement, which derives from the Latin verb *aptare* (to fit, adapt); namely, the word *apterata* in Finnish, *aptera* in Swedish, roughly meaning the judgement involved in dividing up trunks when the log-length is variable. This is particularly connected with the preparation of sawlogs in that each log should be of the maximum possible similarity in quality (judged from the standpoint of the quality of sawn goods to be obtained from the log) throughout its length. This being the case, it is, for instance, an error to cut the most valuable part of the trunk, the butt log, in such a way that its top end comprises wood so knotty that it lowers the quality class of the largely knot-free sawn goods to be obtained. Thus, in Finnish the term *apterata* primarily means the judgement involved in

dividing the trunk into log lengths and the related measurement of these log lengths, which aims at profit maximization of the sawing yield. In the other languages of Northern Europe the word *aptera* (the word varies somewhat depending on the language in question: Danish, Norwegian or Swedish) also means the length measurement of logs of standard length. The term under consideration may have come directly from the Latin *aptare* = 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):

*quassatam ventis liceat 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, — — —. Referring to this passage, SEIDENSTICKER (I, p. 308) expresses the view that »*Balken zimmern nannten die Römer 'trabes aptare'*«. STRENG'S Latin-Finnish dictionary gives »to hew beams from forest trees» as the meaning of the expression *silvis trabes aptare* and further observes that poetic diction is in question.

For my part I would not be so poetic. The passage narrates how part of the Greek fleet commanded by Aeneas managed to get through a violent storm and land on the Libyan coast in the territory ruled by Queen Dido. Aeneas hopes to gain the queen's permission to beach his wind-battered fleet and to fashion new oars to replace those snapped in the storm so that he and his mariners might sail on to Italy to fulfill their god-given mission of founding on Italian soil an empire that would hold sway over the world in the future. I should interpret the expression *silvis aptare trabes* as meaning in-the-forest cutting of trunks to oar-length logs from which oars would then be fashioned on the beach. Since in multi-oared ships the oars of the various decks were of differing length, the length of the logs really had to be »fit» or »adapted» in accordance with the lengths of the oars. Attention should also be drawn to the fact that the word *trabs* means the severed part of a trunk; hence, log, or in construction terminology, round supporting timber, but not

hewn timber. (See, for example, the quotation from VIRGIL in the following paragraph).

We have already mentioned the wedge (Lat. *cuneus*), which VIRGIL says was used in splitting trees before it was discovered how to temper saw blades. This seems to point primarily to the splitting of trees after their removal from the forest, but in VIRGIL'S Aeneid there is also a passage (VI. 179—182) in which the wedge is clearly mentioned as a logging tool:

*itur in antiquam silvam, stabula alta ferarum;
procumbunt piceae, sonat icla securibus ilex
fraxinaeque trabes cuneis et fissile robur
scinditur, advolvunt ingentis montibus ornos.*

Large trimmed and cross-cut trunks intended for use in construction were probably not in general treated in the forest to any great extent, for example, barked or hewn, — at least if hauling over rather long distances was involved — because they would have suffered a bad pounding while being transported. It sometimes happened that the place where the logs were treated 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 order to extricate himself 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 confine.
The fir-tree, poplar, and heaven-scaling pine,
Had there their offspring. Of which, those that were
Of driest matter, and grew longest there,
He choosed for lighter sail. This place thus shown,
The Nymph turn'd home. He fell to felling down,
And twenty trees he stoop'd in little space,
Plain'd, used his plumb, did all with artful grace.

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

SEIDENSTICKER (1886 II, p. 320) conjectures that PALLADIUS' agricultural calendar (*De re rustica*) explicitly reveals that large-sized trees were hauled intact. In support of this notion he has quoted from the Latin of the above-mentioned work a rather long passage 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 irri-

gation.¹⁶ The mention of bobbing of branches made in this context (*truncatis ramis*) may have misled my German colleague.

The relief seen in Fig. 12 appears most promising from the viewpoint of our study of ancient logging tools. It depicts, among other things, a bucksaw, 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, woodworking tools (*dolabra* 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 from 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 cause to protect their ears on this account, 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 may be imagined that they belonged to 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, well known.

The stone seen in Fig. 12, which according to GUMMERUS (1913) is a votive stone and which is preserved in the Capitulum museum, was likely originally housed in the meeting hall of the Roman Carpenters' Union (*collegium 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 erection of the monument 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



← Fig. 12. A Roman votive stone from the first years of our era (GUMMERUS 1913).

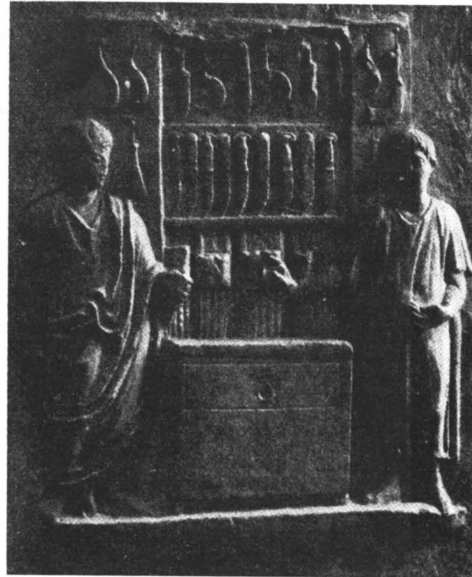
↑ Fig. 13. The cutler L. Cornelius Atimetus' shop. It is possible that Atimetus himself is shown serving a customer. A tombstone dating from the first century A.D., now in the Vatican (GUMMERUS 1913).

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, »Holz-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 knifemaker Atimetus 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, Atimetus 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.»¹⁷

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 since ancient 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 10:5. Accordingly, when using 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 »cleaning« of trees be done in winter, but not during a period when the bark is frozen.¹⁸ 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 otherwise 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 »forchlight shift« was thus $\frac{5}{60} \times 9 = \frac{3}{4}$

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, informs us that the daily work output for vineyard poles was 30 pieces and the corresponding figure for fence 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 lighting PLINY gives the same figures as COLUMELLA.¹⁹ If the forest workers of ancient times had had modern-type labour unions, they would have certainly used PLINY as their expert advisor in collective bargaining, 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, can be believed to have made 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-metre barked bolts of pulpwood 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 precise-

ly square shape by a single workman, and all these amounts are likewise called loads.»²⁰ 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 next to 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 as were 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 × 7 inches in thickness. Before the First World War beams up to 12 × 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 × 10-inch pine balks, the result obtained is about 35 ft., or 10 feet more than the hewing yield 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 FORSTER and HEFFNER, who have translated chapters V—XII of COLUMELLA's work into English, have rendered the first sentence of the above-cited passage (Lat. *Materies si roborea est, ab uno fabro dolari ad unguem per quadrata debet pedum XX: haec erit vehis una.*) 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 *dolari ad unguem 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 (*abies atque populus ad unguem 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; omnes eae mensurae similiter vehes appellantur*). It was not in the least a 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 used 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 7 200 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 (GRIMBERG 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 at 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 Iliad» (XXIII 117—124, translated by GEO. 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.²¹

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 *autostrada* 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 (*advolvunt ingentis montibus ornos*). The Bible tells (1 Kings 5:8, 9) that the slaves («servants», 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. DORÉ 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, MAKKONEN 1959 and 1960).

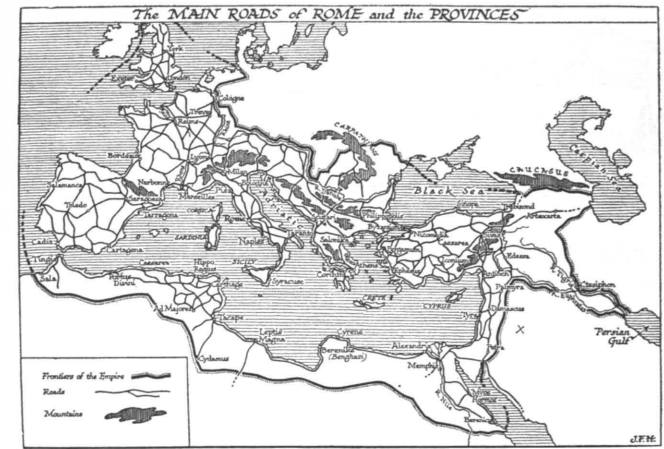


Fig. 15. Highway system of the Roman Empire in the second century A.D. (SINGER et al. 1956, MAKKONEN 1959 and 1960).

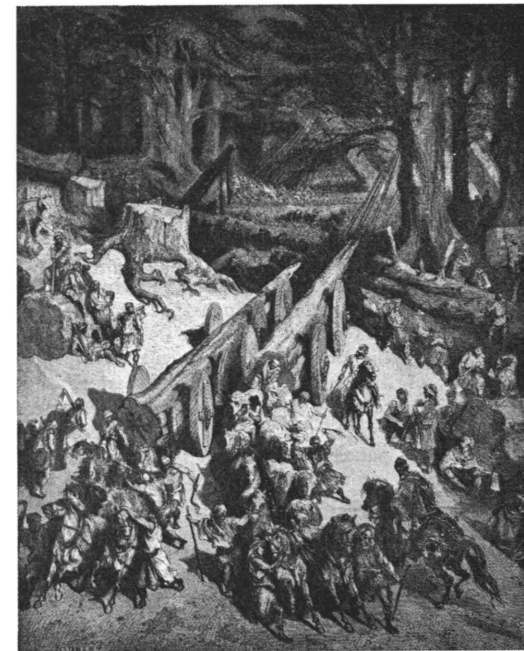


Fig. 16. Bible illustrator's conception of the transport of Lebanon cedars.

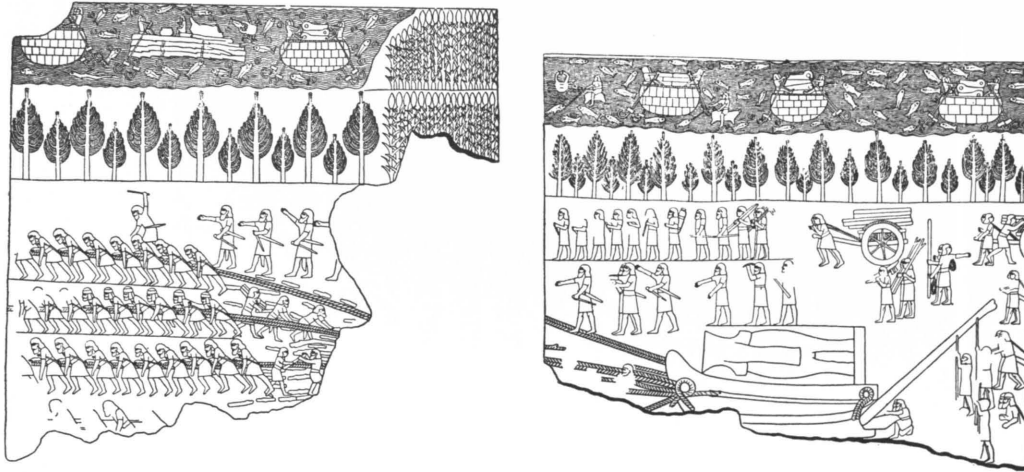


Fig. 17. Transporting a gigantic statue in a sled drawn by a large gang of slaves. The sled has apparently got stuck. A post serving as a lever is being held in an inclined position and set in place. A seventh century B.C. wall relief from Sanherib's palace in Nineveh (SINGER et al. 1956, MAKKONEN 1959 and 1960).

of sets of wheels to facilitate the work of pulling. This may not be entirely impossible 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 another 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).

SAARISALO (1965) in his Companion to the Bible also calls the cedar a broad-branched 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

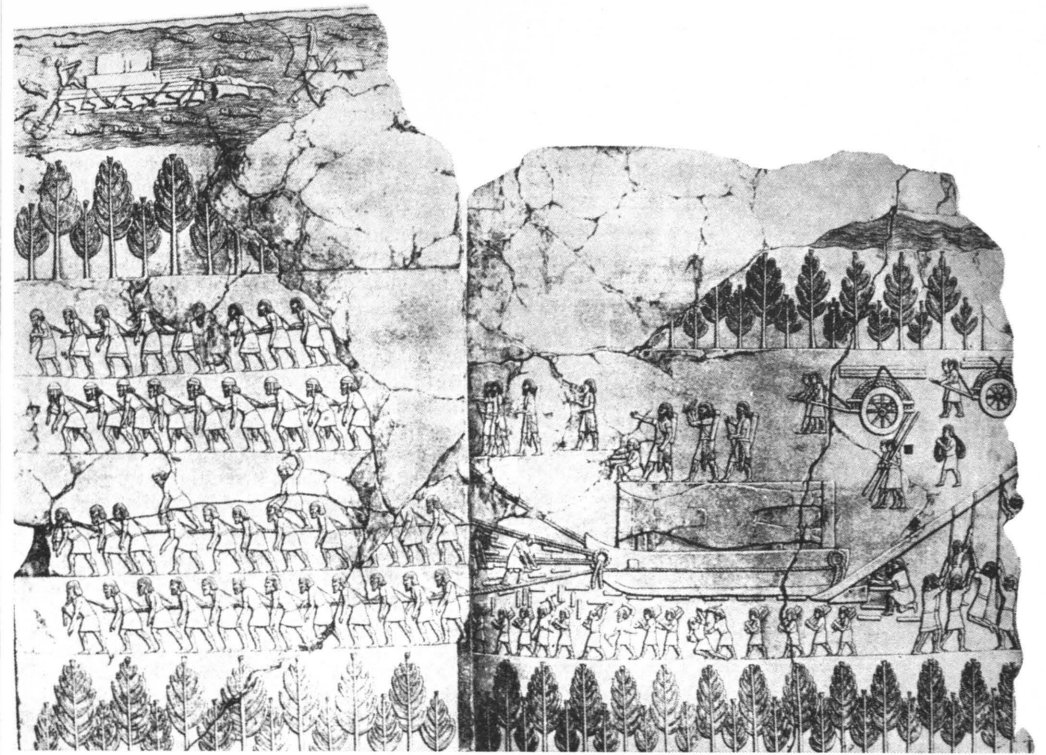


Fig. 18. Another glimpse of the same labour. The work of getting the sled free has already progressed a bit. The lever is in place and its upper end is being pulled downward by means of ropes (FELDHaus 1931, MAKKONEN 1959 and 1960).

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 passages 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 Dächsel,
zur scharur-Waffe, dem 'rechten Arm von
Lagash',
der Waffe, dem Orkan seines Königs,
spaltete er sie mit dem Dächsel:
Wie eine grosse Schlange, die ins Wasser . . .
ist sie.*

*Aus dem Zedernberg liess er Zedernbalken,
aus dem zabalum-Berg liess er zabalum-Balken,
grosse Tannen, Platanen, eranum-Stämme,
grosse, übergrosse Balken daraus,
am hohen 'Kai des Strahlenden Tores' (anlegen).*

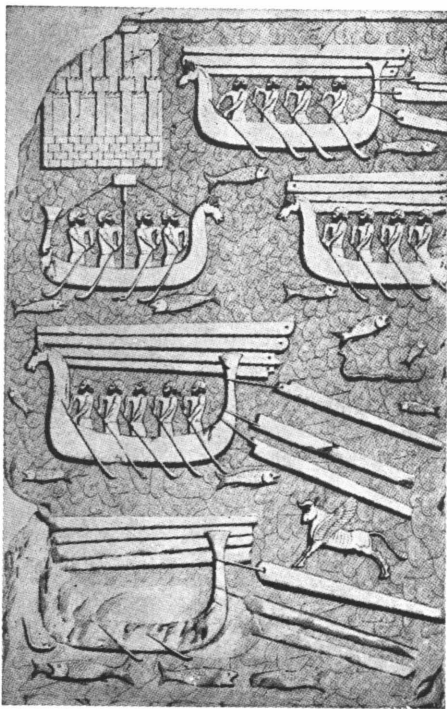


Fig. 19. A wall relief from Sanherib's palace showing logs being towed as well as transported by ship (SALONEN 1939, MAKKONEN 1954 and 1961).

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 Zederngebirge liess er Zedernflösse, aus dem Zypressengebirge Zypressenflösse . . . grosse übergrosse Flösse 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 *quppu* 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 «tugboat» used is not mentioned but it could scarcely have been other than a multioared 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. VIRGIL (Georgics II, 451—452) mentions the floating of wood down the P o River (*nec non et torrentem undam levis innatat alnus missa Pado*)

and PLINY speaks of the floating of logs, and to some extent also of rafts, down the Tiber.²² 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.²³ Wood of this sort was, at any rate, transported from the slopes of the Alps along the Po all the way to Ravenna.²⁴

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-four shekels a tonne (SALONEN 1945, pp. 174 and 283). 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.

DEIMEL (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 Vollernte eines einzelnen vollausgewachsenen 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 dealing in jewels and gold. It is derived from the Greek word *κεράτιον* meaning the pod of the carob-tree (*Ceratonia siliqua*). *Κεράτιον* is in turn the diminutive of the word *κέρας*, 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 (2778—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

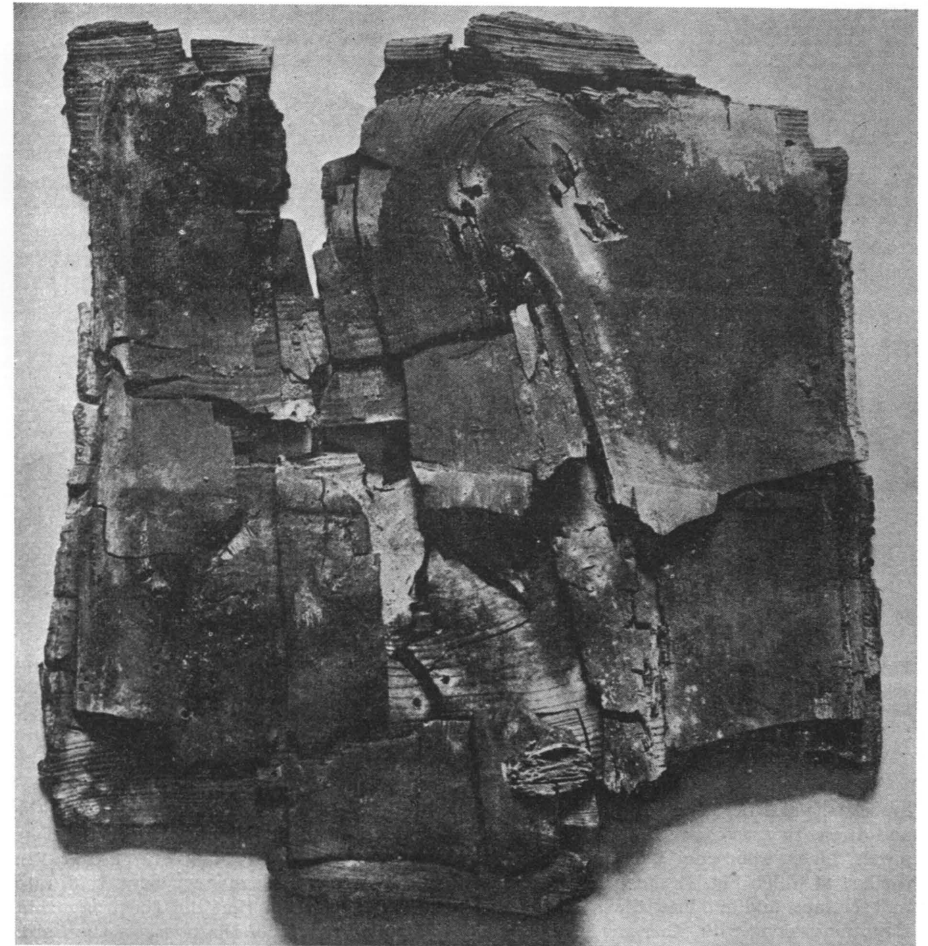


Fig. 20. Six-ply plywood from nearly 5000 years ago. A small piece of the coffin of the Pharaoh's ten years old daughter, from the period of the third dynasty, 2778—2723 B.C. (LAURENT-TÄCKHOLM 1951).

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 (fif-

teenth 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 (*Balsamodendron 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

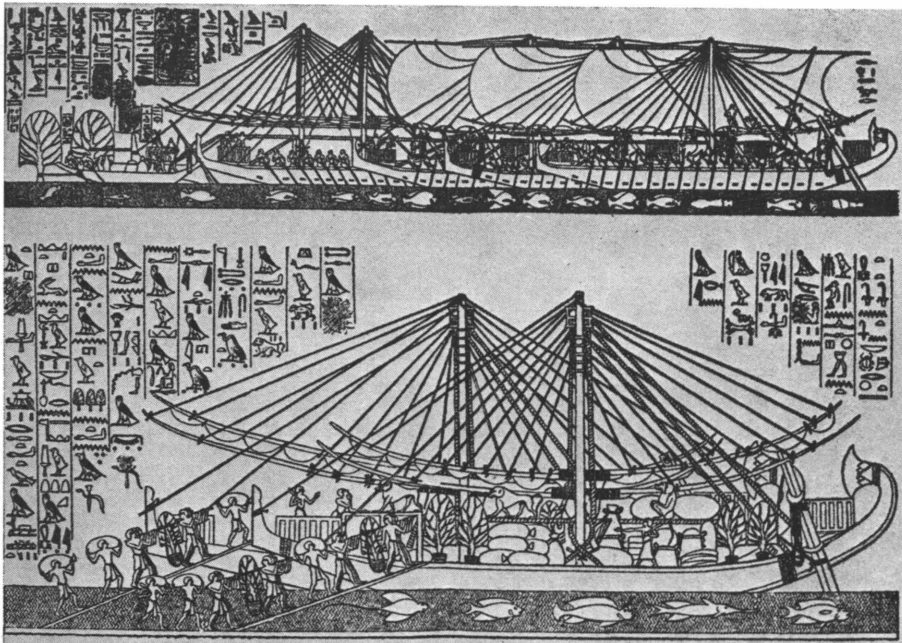


Fig. 21. Glimpses of the Egyptians' expedition to the land of Punt ca. 1480 B.C. In the upper picture the ships are leaving Egypt. In the lower picture the Egyptians' ships are in the land of Punt and among the goods being loaded into them are living myrrh-trees complete with their rootclumps. Picture from the temple at Deir el Bahar (LAURENT-TÄCKHOLM 1951).

bracelets, pearl necklaces, daggers and axes and these they exchanged for gold, silver, jewels, black wood and living myrrh-trees, the last of which Fig. 21 shows being carried root clumps and all into the ships of the Egyptians, along with other goods. Hatshepsut immortalized this wondrous sea expedition in the walls of the temple of Amon, which she had built in Deir el Bahar. The myrrh-trees were obtained for the purpose of landscaping the front terraces of this temple. Afterwards it was not befitting the dignity of the Pharaoh to tell that all the goods brought from Punt were obtained by exchange and for this reason they are mentioned as taxes paid by the king of Punt to Egypt's Pharaoh. (GRIMBERG I, pp. 128—132; LAURENT-TÄCKHOLM 1951, pp. 178—181).

Here and there the Bible makes mention of timber trade in wooden goods. The follow-

ing is related about the restoration of the dilapidated temple of Jerusalem in the time of King Jehoash (2 Kings 12:11 and 12): »And they gave the money, being told, into the hands of them that did the work, that had the oversight of the house of the Lord: and they laid it out to the carpenters and builders, that wrought upon the house of the Lord, and to masons and hewers of stone, and to buy timber and hewed stone to repair the breaches of the house of the Lord, and for all that was laid out for the house to repair it.»

When King Hiram of Tyre supplied Solomon with Lebanon cedars and cypresses needed for building the temple, a fairly large business deal was in the balance. The price was 20 000 *koors* (the Hebrew form for the *kur*) of wheat and the same quantity of oil yearly, apparently for the duration of Hiram's life (1 Kings 5:6—10). Concerning the quan-

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.¹ Merchants have evidently had the same inclinations throughout the ages. In Finland, for example, much furniture of irocco wood (*Chlorophora excelsa*) has been sold as teak (*Teclona grandis*). In defense of the merchants it must, however, be said that irocco 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 mistaken regarding a barked tree.² 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 a planted stand (*arbustum*; 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.³ CATO surmises that willows from willow plantations established on such a farm will also sell well.⁴ 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.⁵

Valuable trees were also brought from far-away. The Bible accordingly mentions (Ezekiel 27:15) that Tyre 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 cuci-tree (*Hyphaene Thebaica*), which grows in Egypt, for the waviness of its grain⁶, 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 Elymais (in present-day western Iran) to be used as incense.⁷ 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.⁸

In Chapter 19 (*De actionibus empti venditi*) 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.⁹ 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 Trigemina* 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.¹⁰

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*).¹¹ 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.¹² One of HORACE's »poetic 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.¹³ When discussing the preparation of bronze,

PLINY speaks of the lack of firewood in many parts of Italy and also in the provinces.¹⁴

Regarding the prices forest owners got for wood, a couple of facts have been preserved. PLINY mentions that poles and staffs 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».¹⁵ 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 (*iugerum*, about 0.25 ha.).¹⁶ According to STRENG'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 Gaius. 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.¹⁷ 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 Hybreae, 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.¹⁸

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.¹ 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 *tala*-tree (a species of fan-palm).² Bark was also eaten by the Indian soothsayers (*oi sopistai*), who belonged to the first caste.³ 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.^{4, 5, 6} 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.⁷ 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 rope⁸ and weaving baskets.⁹ 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 sidenote 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*).¹⁰ The ichthyophages of India (a fish-eating tribe) wove their nets from twisted thread made from the bark of the date-palm.¹¹ The bark of the alder¹², sumach¹³ and Aleppo pine¹⁴ was used in dyeing 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: *tegmina quis capitum raptus de subere cortex*). This is, however, the only reference to this effect. Cork has been widely used to stopple wine jugs 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, *betul(l)a*, 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

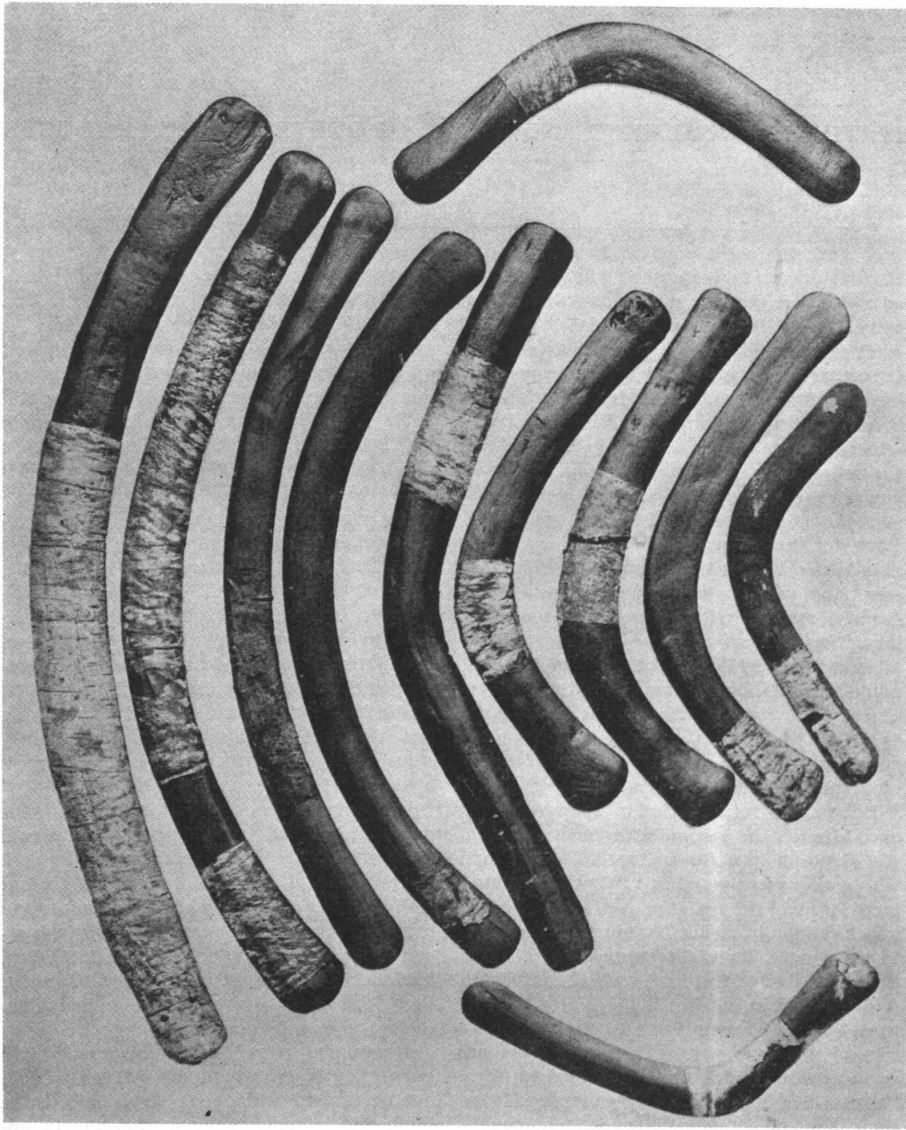


Fig. 22. «Boomerangs» decorated with birch bark, found in the tomb of Tutankhamen. These artifacts probably served as symbols in some sort of religious rite. Egyptian museum, Cairo. Photo Harry Burton (LAURENT-TÄCKHOLM 1951).

into Gaul. In view of this one wonders how it can be explained that the tomb of Pharaoh Tutankhamen (mid fourteenth century B.C.)

has yielded up many different objects decorated with birch bark: artifacts resembling boomerangs (Fig. 22), bow cases and walking

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-NOBLECOURT 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 thusfar 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):

Were the Lotophagi, 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 address
Any return t'inform what sort of men
Made fix'd abode there; but would needs maintain
Above themselves there, and eat that food ever.

HERODOTUS (IV. 177) and THEOPHRASTUS (IV. III.1) both mention lotophags or lotus eaters.

Let us now return to a point mentioned in the first part of this study (MAKKONEN

1967, pp. 52—54). The holy *shoab*-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 *Mimusops Schimperii* on the ground that 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 *mimusops*-tree being sold in the market place of a small village. Upon inquiring what the name of this fruit was, he received the answer «*lebbakh*». SCHWEINFURTH says that he was entirely unaware of the fact that the fruit of the *mimusops*-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.¹⁵

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 eloquently¹⁶, 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

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 eastern Roman world, Constantine VII Porphyrogenetus, 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

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*).¹⁷ 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.¹⁸ Other resinous fluids and oils that were much sought after and 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 (*Balsamodendron opobalsamum*) 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 connexions.

The use of cedar oil in the embalming of bodies is deserving of especial mention. One of the writers to describe this is HERODOTUS.¹⁹ 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

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 citron-tree but to a tree named *Callitris quadrivalvis*. The orange was apparently totally unknown in antiquity.

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 shew 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.»²⁰

The great size of these ancient tar pits

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 (*σπόγγοι*) 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 mushrooms as food or about their possible value as trade commodities. Nevertheless, he knew of such species as the truffle (*ῥόδον*) and cap mushroom (*μύκης*).

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 propraetor Lartius Licinius broke his front teeth while eagerly chewing a truffle into which a dinar that had been dropped on the ground had chanced to find its way.²² PLINY also speaks of the poisonousness of mushrooms and tells that whole families along with their table guests

arouses wonder but might nevertheless have been within feasible limits. As for the latter of the alternative measurements mentioned, however, it is likely that the text was damaged in this place and that erroneous measurements were preserved in the successive copies of it, for a tar bonfire the height of which is as great as the circumference at ground level is in all probability not a practical possibility. The kindling and covering of earth would not stand on top of such a tower.

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?»²³ PLINY also makes separate mention of mushrooms that grow on trees. He was acquainted with, for example, corky fungus (polypore) from which tinder needed for making fire was obtained. He uses the name *fungus aridus* (dry mushroom) for this species.²⁴ 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 Libyan poplar (apparently a local strain of the black poplar), which have very small and dark leaves and which are famous for the mushrooms that grow on them.²⁵ In Gaul there occurred in the crowns of oaks a pungent white mushroom (*agaricum*) 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.²⁶

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.²⁷ 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.²⁸

BIBLIOGRAPHY

Abbreviations

LCL = Loeb Classical Library

SCBO = Scriptorum Classicorum Bibliotheca Oxoniensis

AMMIANUS Marcellinus I. With an English Translation by John C. Rolfe. LCL 1950.

→ II. With an English Translation by John C. Rolfe. LCL 1950.

→ III. With an English Translation by John C. Rolfe. LCL 1952.

APOLLODORI Bibliotheca. Ex recognitione Rudolfi Hercheri. Berolini apud Weidmannos. MDCCCLXXIV.

APULEIUS. Der goldene Esel. Metamorphosen. Lateinisch und Deutsch. Herausgegeben und übersetzt von Edward Brandt. Zum Druck besorgt von Wilhelm Ehlers. Tusculum-Bücherei. Bei Heimeran. München 1958.

ARO, PAAVO. 1945. Metsäsahojen kunnostamisen pääperiaatteet. Metsätyöntutkimukset. Suomen Puunjalostusteollisuuden Keskusliiton Metsätehotoimiston (Metsätehon) julkaisuja n:o 1. Helsinki.

ARRIAN I. With an English Translation by E. Iloff Robson. Anabasis Alexandri Books I–IV. LCL 1954.

→ II. With an English Translation by E. Iloff Robson. Anabasis Alexandri Books V–VII. Indica Book VII. LCL 1949.

BEEKMAN, W. BOERHAVE. 1949. Hout in alle tijden. Bossen, bomen en toegepast hout in het verleden. Deel I. Prae-historie en Historie tot en met de Iraniërs. N.V. Uitgevers-maatschappij Æ. E. Kluwer. Deventer, Batavia, Bandoeng, Semarang, Soerabaia.

→ 1949. Hout in alle tijden. Bossen, bomen en toegepast hout in het verleden. Deel II. Historie van de Grieken tot en met de Byzantijnen; bijzondere toepassingen tot het eind der XIXe eeuw. N.V. Uitgevers-maatschappij Æ. E. Kluwer. Deventer, Batavia, Bandoeng, Semarang, Soerabaia.

Biblia Triglotta; continentia scripturas sacras Veteris et Novi Testamenti; scilicet: Textus Originales, una cum versionibus Septuaginta, Syriaca (Novi Testamenti), Vulgata, parallelo ordine positos. Tomus I. — Vetus Testamentum. Londini MDCCCXC.

BREASTED, J. H. 1948. A history of Egypt. London. Gaius Julius CAESAR. Gallian sota. Toinen painos. Latinasta suomentanut ja selityksillä varustanut Gunnar Rancken. Kariston klassillinen kirjasto 40. Hämeenlinna 1949.

Marcus Porcius CATO — Marcus Terentius VARRO. On Agriculture. With an English Translation by William Davis Hooper. LCL 1954.

Lucius Junius Moderatus COLUMELLA I. On Agriculture. With a Recension of the Text and an English Translation by Harrison Boyd Ash. Res rustica I–IV. LCL 1948.

Lucius Junius Moderatus COLUMELLA II. On Agriculture. With a Recension of the Text and an English Translation by E.S. Forster and Edward H. Heffner. Res rustica V–IX. LCL 1954.

→ III. On Agriculture and Trees. With an Recension of the Text and an English Translation by E.S. Forster and Edward H. Heffner. Res rustica X–XII, De arboribus. LCL 1955.

Corpus iuris Civilis I. Institutiones, recognovit Paulus Krueger. Digesta, recognovit Theodoros Mommsen, retractavit Paulus Krueger. Apud Weidmannos. Berolini 1954.

→ II. Codex Iustinianus, recognovit et retractavit Paulus Krueger. Aqud Weidmannos. Berolini 1954.

→ III. Novellae, recognovit Rudolph Schoell. Opus Schoelli morte interceptum absolvit Guillelmus Kroll. Apud Weidmannos. Berolini 1954.

CRUG, K. Wald, Holz und Jagd bei Homer. Forstwissenschaftliches Centralblatt 1954, ss. 290–308.

Quintus CURTIUS II. With an English Translation by John C. Rolfe. Litt. D. LCL 1962.

DEIMEL, P. 1925. Die Altäumerische Baumwirtschaft. Orientalia 16. Roma.

→ 1931. Sumerische Tempelwirtschaft zur Zeit Urukaginas und seiner Vorgänger. Analecta Orientalia 2. Roma.

DEVÈZE, M. 1961. La vie des forêts françaises. Thèse pour le Doctorat ès Lettres. 2 vol. Paris.

DIODORI Bibliotheca Historica. Editionem primam curavit Imm. Bekker, alteram Ludovicus Dindorf. Recognovit Fridericus Vogel. Vol. I. Lipsiae in aedibus B. G. Teubneri. MDCCCLXXXVIII.

FELDDHAUS, FRANZ MARIA. 1931. Die Technik der Antike und des Mittelalters. Leipzig.

GRIMBERG, CARL. Kansojen historia 1–6. Werner Söderström Osakeyhtiö. Porvoo–Helsinki 1957.

GUMMERUS, H. 1913. Darstellungen aus dem Handwerk auf römischen Grab- und Votivsteinen in Italien. Jahrbuch des Kaiserlich Deutschen Archäologischen Instituts. Band XXVIII. Druck und Verlag von Georg Reimer. Berlin.

HAFNER, FRANZ. 1955. Zur Geschichte des Wassertransportes von Holz, besonders in Österreich und Deutschland, von den Anfängen bis zur Jetztzeit. Zentralblatt für das gesamte Forstwesen. Sonderabdruck aus Heft 1, 74. Jahrgang. Wien.

HAFNER, FRANZ. 1961. Die geschichtliche Entwicklung des forstlichen Bau- und Bringungswezens im Spiegel des deutschsprachigen Fachschrifttums. Centralblatt für das gesamte Forstwesen. Sonderdruck aus Heft 2, 78. Jahrgang. Wien.

HERODOTI Historiae Libri I–IV. Recognovit brevique adnotatione critica instruxit Carolus Hude. SCBO 1955.

→ Historiae Libri V–IX. Recognovit brevique adnotatione critica instruxit Carolus Hude. SCBO 1954.

The Holy Bible containing the Old and New Testaments. Translated out of the original tongues and with former translations diligently compared and revised by His Majesty's Special Command. Appointed to be read in Churches. Authorized King James Version. Collins' Clear-Type Press. London and New York. S.a.

The Whole Works of HOMER: Prince of Poets. In his Iliads, and Odysseys. Translated according to the Greek by Geo. Chapman. Chatto & Windus. London 1924.

HOMERI Opera. Iliadis I–XII. Recognoverunt brevique adnotatione critica instruxerunt David B. Monro et Thomas W. Allen. SCBO 1946.

HOMER. Iliad, Books XIII–XXIV. With notes by D.B. Monro. At the Clarendon Press. Oxford 1949.

HOMERI Opera. Odysseae I–XII. Recognovit brevique adnotatione critica instruxit Thomas W. Allen. SCBO 1954.

→ Opera. Odysseae XIII–XXIV. Recognovit brevique adnotatione critica instruxit Thomas W. Allen. SCBO 1955.

HOMEROS. Ilias. Suomentanut O. Manninen. Kolmas painos. WSOY. Porvoo–Helsinki 1948.

→ Odyssea. Suomentanut O. Manninen. Kolmas painos. WSOY. Porvoo–Helsinki 1948.

Q. HORATI Flacci Opera. Recognovit brevique adnotatione critica instruxit Eduardus C. Wickham. SCBO 1952.

HYGINI Fabulae. Recensuit, prolegomenis commentario appendice instruxit H. I. Rose M. A. Lugduni Batavorum apud A. W. Sijthoff. 1934.

LAURENT-TÄCKHOLM, VIVI. Faraos blomster. 1951. En kulturhistoriskbotanisk skildring av livet i Gamla Egypten byggd på verklighetens grundval och med bilder från de sista årens grävningar. Natur och Kultur. Stockholm.

LINKOMIES, EDWIN. 1947. Antiikin kulttuuri tutkimuksen kohteena. Otava. Helsinki.

→ 1948. Homeros. Otava. Helsinki.

LIVY II. With an English Translation by B. O. Foster. Books III and IV. LCL 1953.

→ IV. With an English Translation by B. O. Foster. Books VIII–X. LCL 1948.

→ VI. With an English Translation. Books XXIII–XXV. Translated by Frank Gardner Moore. LCL 1951.

→ VIII. With an English Translation. Books XXVIII–XXX. Translated by Frank Gardner Moore. LCL 1955.

→ IX. With an English Translation by Evan T. Sage. Books XXXI–XXXIV. LCL 1953.

MAKKONEN, OLLI. 1954. Puutavaran kuljetuksen ja kaupan varhaishistoriaa (The Early History Of Timber Transport and Timber Trade). Metsätaloudellinen Aikakauslehti n:o 1, 1954. Helsinki.

→ 1958. Vanhan ajan oppineiden tiedot puiden rakenteesta. Metsätaloudellinen Aikakauslehti n:o 3–4/1958. Helsinki.

→ 1959. Vanhimmat tietomme puutavaran hankinnasta (Our Earliest History of the Logging of Timber). Metsätaloudellinen Aikakauslehti n:o 8, 1959. Helsinki.

→ 1960. Vår äldsta kändedom om drivning. Referat av utländska tidnings- och tidskriftsartiklar, Nr. 5, Mars 1960. Föreningen Skogsarbetens och Kungliga Domänstyrelsens Arbetsstudieavdelning (SDA). Stockholm.

→ 1961. Fornhistorisk blick på virkestransport och -handel. Referat av utländska tidnings- och tidskriftsartiklar, Nr 11, Juni 1961. Föreningen Skogsarbetens och Kungliga Domänstyrelsens Arbetsstudieavdelning (SDA). Stockholm.

→ 1962. Antiikin kirjallisuuden metsää sivuavienaintojen tulkintavaikeuksista. Summary: The difficulty of interpreting statements concerning forests in ancient literature. Communicationes Instituti Forestalis Fenniae 55.17. Helsinki.

→ 1966. Die Holzernte im Altertum. Zeitschrift für Agrargeschichte und Agrarzoologie. Jahrgang 14. Heft 2. November 1966. DLG-Verlag-GmbH. Frankfurt am Main.

→ 1967. Ancient Forestry. An Historical Study. Part I. Facts and Information on Trees. Reprint from Acta Forestalia Fennica 82. Helsinki.

NÄSLUND, O. J. 1937. Säger. Bidrag till kändedomen om sägarnas uppkomst och utveckling. Eslette Aktiebolag. Stockholm.

P. OVIDI Nasonis Metamorphoseon libri XV. Lactanti placidi qui dicitur narrationes fabularum Ovidianarum. Recensuit, apparatu critico instruxit Hugo Magnus. Berolini apud Weidmannos. MDCCCCXIV.

PALLADII Rutilii Tauri Aemiliani viri illustriis opus agriculturae ex recensione I. C. Schmittii. Lipsiae in aedibus B. G. Teubneri. MDCCCLXXXVIII.

PLINY I. Natural History. With an English Translation by H. Rackham. Praefatio, libri I, II. LCL 1949.

→ II. Natural History. With an English Translation by H. Rackham. Libri III–VII. LCL 1947.

→ III. Natural History. With an English Translation by H. Rackham. Libri VIII–XI. LCL 1956.

→ IV. Natural History. With an English Translation by H. Rackham. Libri XII–XVI. LCL 1952.

→ V. Natural History. With an English Translation by H. Rackham. Libri XVII–XIX. LCL 1950.

→ VI. Natural History. With an English Translation by W. H. S. Jones. Libri XX–XXIII. LCL 1951.

→ VII. Natural History. With an English Trans-

- lation by W. H. S. Jones. Libri XXIV—XXVII. LCL 1956.
- PLINY IX. Natural History. With an English Translation by H. Rackham. Libri XXXIII—XXXV. LCL 1952.
- RUBNER, HEINRICH. 1965. Griechischer Geist und forstliches Wissen. Allgemeine Forst und Jagdzeitung. 136. Jahrgang, Heft 6, Juni. J. D. Sauerländer's Verlag. Frankfurt am Main.
- 1967. Forstgeschichte im Zeitalter der industriellen Revolution. Schriften zur Wirtschafts- und Sozialgeschichte. In Verbindung mit Rudolf Braun, Otto Büsch und Rolf Engelsing herausgegeben von Wolfram Fischer. Band 8. Duncker & Humblot. Berlin.
- RÜHLMANN, MORITZ. 1865. Allgemeine Maschienenlehre. Braunschweig.
- RUSSELL, W. M. S. 1967. Man, Nature and History. Aldus Books. London.
- SAARISALO, APELI. 1965. Raamatun sanakirja. Werner Söderström Osakeyhtiö. Porvoo—Helsinki.
- SALONEN, ARMAS. 1939. Die Wasserfahrzeuge in Babylonien nach sumerisch-akkadischen Quellen. Eine lexikalische und kulturgeschichtliche Untersuchung. Helsinki.
- 1945. Kaksoisvirranmaa eli kuvauksia ja kuvia Babylonian ja Assyrian kulttuurista nuolenpäätekstien ja kaivaustulosten perusteella. WSOY. Porvoo—Helsinki.
- 1965. Bemerkungen zur sumerisch-akkadischen Brennholz-Terminologie. Jaarbericht van het voorzitatisch-egyptisch genootschap »Ex Oriente Lux«. No. 18. Leiden.
- 1966. Die Hausgeräte der alten Mesopotamier nach sumerisch-akkadischen Quellen. Teil II: Gefäße. Eine lexikalische und kulturgeschichtliche Untersuchung. Annales Academiae Scientiarum Fennicae, Ser. B. Tom. 144. Helsinki.
- SANDERMANN, W. 1958. Also sprach Theophrastus. Ein Blick in vergessene Bücher der Holzkunde und Holztechnologie des Altertums. Holz-Zentralblatt Nr. 29. Stuttgart.
- SCHWEINFURTH, G. 1886. Die letzten botanischen Entdeckungen in der Gräbern Ägyptens. Englers Botanische Jahrbücher 8: 1, Leipzig.
- 1904. Das älteste Herbarium der Welt. Vossische Zeitung, 25 November. Berlin.
- SEIDENSTICKER, AUGUST. 1886. Waldgeschichte des Alterthums I. Vor Cäsar. Trowitzsch & Sohn. Frankfurt a. Oder.
- 1886. Waldgeschichte des Alterthums II. Nach Cäsar. Trowitzsch & Sohn. Frankfurt a. Oder.
- L. Annaei SENECAE ad Lucilium epistularum moralium libros I—XIII ad codicem praecipue Quirinianum recensuit Achilles Beltrami. Brixiae typis F. Apollonii et S. MCMXVI.
- SINGER, CHARLES, HOLMYARD, E. J. and HALL, A. R. 1956. A History of Technology. Volume I. From Early Times to Fall of Ancient Empires. At the Clarendon Press. Oxford.
- SINGER, CHARLES, HOLMYARD, E. J., HALL, A. R. and WILLIAMS, TREVOR I. 1956. A History of Technology. Volume II. The Mediterranean Civilizations and the Middle Ages c. 700 B.C. to c. A.D. 1500. At the Clarendon Press. Oxford.
- STRABO. The Geography I. With an English Translation by Horace Leonard Jones, A.M., Ph. D. Based in Part upon the Unfinished Version of John Robert Sitlington Sterret, Ph. D., LL. D. LCL 1949.
- The Geography II. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1949.
- The Geography III. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1954.
- The Geography IV. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1954.
- The Geography V. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1954.
- The Geography VI. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1950.
- The Geography VII. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1954.
- The Geography VIII. With an English Translation by Horace Leonard Jones, Ph. D., LL. D. LCL 1949.
- Sumerische und akkadische Hymnen und Gebete. Eingeleitet und übertragen von A. Falkenstein und W. von Soden. Die Bibliothek der Alten Welt. Artemis-Verlag. Zürich—Stuttgart 1953.
- SVENNUNG, J. 1935. Untersuchungen zu Palladius und zur lateinischen Fach- und Volkssprache. Lund.
- THEOPHRASTUS I. Enquiry into Plants and Minor Works on Odours and Weather Signs. With an English Translation by Sir Arthur Hort. LCL 1948.
- II. Enquiry into Plants and Minor Works on Odours and Weather Signs. With an English Translation by Sir Arthur Hort. LCL 1949.
- VIRGIL I. With an English Translation by H. Rushton Fairclough. Eclogues, Georgics, Aeneid I—VI. LCL 1956.
- II. Wit an English Translation by H. Rushton Fairclough. Aeneid VII—XII, The Minor Poems. LCL 1954.
- VIRGILI Bucolica et Georgica, öfversatta af Gudmund Jöran Adlerbeth. Andra Upplagan. Stockholm. Tryckta hos A. Gadelius, 1814. På A. Wiborgs förlag.
- VITRUVIUS I. On Architecture. Edited from the Harleian Manuscript 2767 and Translated into English by Frank Granger. LCL 1955.
- II. On Architecture. Edited from the Harleian Manuscript 2767 and Translated into English by Frank Granger LCL 1956.
- WILKINSON, JOHN GARDNER. 1854. A Popular Account of the Ancient Egyptians. London.

REFERENCES IN THE ORIGINAL

- II 1. HESIOD, Works and Days 420—422: τῆμος ἀδικροτάτη πέλεται τμηθεῖσα σιδήρω ὕλη, φύλλα δ' ἐραεῖα χέει, πρόθοιό δ' ἰλίγει τῆμος ἄρ' ὀλοτομῆν μνημημένος ὥρια ἔργα.
- II 2. THEOPHRASTUS, HP V. 1. 1: Ὠραία δὲ τέμνεσθαι τῶν ξύλων τὰ μὲν οὖν στιρογγύλα καὶ ὅσα πρὸς φλοῖσιμόν ὄταν βλαστάνῃ· τότε γὰρ εὐπεριαιετος ὁ φλοῖός, δὲ δὴ καλοῦσι λοιπὰν, διὰ τὴν ὑγρότητα τὴν ὑπογνωμένην αὐτῶ. μετὰ δὲ ταῦτα δυσπεριαιετος καὶ τὸ ξύλον μέλαν γίνεται καὶ δυσσείδες. τὰ δὲ τετρογγώνα μετὰ τὸν λοιπὸν ἀραιεῖται γὰρ ἢ πελέκῃσι τὴν δυσσείδειαν. ὅλως πᾶν πρὸς ἰσχὺν ὠραῖότατον οὐ μόνον πετανυμένον τῆς βλαστῆσεως ἀλλ' ἔτι ἄλλων ἐκπετᾶν τὸν καρπὸν.
- II 3. THEOPHRASTUS, HP V. 1. 2: δρῶς δὲ ὄφιατάτα κατὰ κειμῶνα μετὰ τὸ μετώπων· ἐάν δὲ ὑπὸ τὸν λοιπὸν τμηθῇ, σήπεται τάχιστα ὡς εἰπεῖν, ἐάν τε ἐμφλοῖος ἐάν τε ἄφλοῖος· — — — τὰ δὲ μετὰ τὴν πέπασιν τὸν καρπὸν ἄβρωστα διαμένει, κἂν ἀλόπιστα ἢ· πλὴν ὑπὸ τὸν φλοῖον ὑποδύομενοι σκώληκες ἐπιτολῆς ἐγγράφουσι τὸ στέλεχος, οἷς καὶ σφραγίσαι χρωστὰί τιες·
- II 4. CATO, Rust. XVII. 1: Cetera materies quae semen habet, cum semen maturum habet, tum tempestiva est. Quae materies semen non habet, cum glubebit, tum tempestiva est. Pinus eo, quia semen viride et maturum habet (id semen de cupresso, de pino quidvis anni legere possis), item quidvis anni matura est et tempestiva.
- II 5. CATO, Rust. XXXI. 2: Ulmeam, pineam, nucem, hanc atque aliam materiem omnem cum effodias, luna decrecente eximito post meridiem sine vento austro.
- II 6. PLINY, NH XVI. LXXIV, 188: tigna et quibus auferat securis corticem a bruma ad favonium aut, si praevnire cogamus, arcturi occasu et ante eum fiducialia, novissima ratione solstitio: dies siderum horum reddentur suo loco.
- II 7. PLINY, NH XVI. LXXIV. 190—191: infinitum refert et lunaris ratio, nec nisi a XX in XXX caedi volunt. inter omnes vero convenit utilissime in coitu eius sterna, quem diem alii interlunii, alii silentis lunae appellant. sic certe Tiberius Caesar concremato ponte naumachiariorum latices ad restituendum caedi in Raetia praefinivit. quidam dicunt ut in coitu et sub terra sit luna, quod fieri non potest nisi noctu. si competat coitus in novissimum diem brumae, illa fit aeterna materies;
- II 8. PLINY, NH XVI. LXXIV. 230: et his autem maior ad firmitatem causa tempestivae caesurae quam immaturae, quippe cum ex olea, durissimo ligno, cardines in foribus diutius immoti plantae modo germinaverint.
- II 9. STRABO XV. 1. 46: Μετὰ γὰρ τοὺς θηρευτάς καὶ τοὺς ποιμένας τέταρτόν φησιν εἶναι μέρος τοὺς ἐργαζομένους τὰς τέχνας καὶ τοὺς καπηλικούς καὶ οἷς ἀπὸ τοῦ σώματος ἡ ἐργασία·
- II 10. ARRIAN, Indica 24.9: τοῖς γὰρ δὴ ὄνῃν ὅσα σιδήρω διαχρᾶσθαι ἐλέγοντο, καὶ τῶν ξύλων ὅσα μαλακώτερα· τὰ δὲ ἄλλα τοῖσι λίθοις τοῖσιν ὀξεῖον ἔκοπτον· σιδήρος γὰρ αὐτοῖσιν οὐκ ἦν.
- II 11. THEOPHRASTUS, HP V. VI. 3: τὰ δὲ χλωρὰ λίαν συμμῖνει καὶ ἐνέχεται ἐν τοῖς ὄδοσι τὰ πρῶματα καὶ ἐμπαλάντει, δι' ὃ καὶ παραλλάττουσιν ἀλλήλων τοὺς ὀδόντας ἵνα ἐξάγηται.
- II 12. PLINY, NH XVI. LXXXIII. 227: arida enim latius quam terebras aut serras cedunt, viridia praeter robur et buxum pertinacius resistent serrarumque dentes replent aequalitate inertia, qua de causa alterna inclinatione egerunt scobem.
- II 13. VIRGIL, Georgics I. 143—144: tum ferri rotur atque argutae lammina serrae nam primi cuneis scindebant fissile lignum, tum variae venere artes. labor omnia vicit improbus et duris urgens in rebus egestas.
- II 14. PALLADIUS I. 42: serrulae manubriatae minores praeter robur et buxum pertinacius resistent serrarumque dentes replent aequalitate inertia, qua de causa alterna inclinatione egerunt scobem.
- II 15. PLINY, NH XXVIII. xli: hircorum sanguini tanta vis est, ut ferramentorum subtilitas non aliter acris induretur, scabritia poliatur vehementius quam lima.
- II 16. PALLADIUS XII. 16: Hoc mense locis siccis, calidis et apricis maiores arbores transferemus truncatis ramis, illaesis radicibus, multo stercore et rigationibus adjuvandas.
- II 17. COLUMELLA, Rust. XI. II. 12: Palos una opera caedere et exputatos acuere centum numero potest: ridicas autem quernae, sive oleaginas findere, et dedolatas utraque parte exacere numero sexaginta. Item ad lucubrationem vespertinam palos decem vel ridicas quinque conficere; totidemque per antelucanam lucubrationem.
- II 18. VARRO, Rust. I. xxvii. 3: Aestate fieri messes oportere, autumnio siccis tempestatibus vindemias, ac silvas excoli commodissime tunc, praecidi arbores oportere secundum terram; radices autem primoribus imbribus ut effodiantur, nequid ex iis nasci possit. Hieme putari arbores dumtaxat his temporibus, cum gelu cortices ex imbribus careant et glacie.
- II 19. PLINY, NH XVIII. LXIII. 232—233: reliqua opera nocturna maxime vigilia constent, cum sint noctes tanto ampliores, quales, crates, fascinas texere, faces incidere, ridicas praeparare interdum XXX, palos LX et in lucubratione vespertina ridicas V, palos X, totidem antelucana.
- II 20. COLUMELLA, Rust. XI. II. 13: Materies si roborea est, ab uno fabro dolari ad unquem per quadrata debet pedum XX: haec erit vehis una. Pinus autem V et XX pedum aequae ab uno expeditur, quae et ipsa vehis dicitur: nec

- minus ulmus et fraxinus pedum XXX; cupressus autem pedum XL; tum etiam sexagenum pedum abies atque populus, singulis operis ad unquem quadrantur, atque omnes eae mensurae similiter vehes appellantur.
- II 21. APULEIUS VII. 17.4: Lignorum vero tanto me premebat pondere, ut fascium molem elephantum, non asino paratam putares.
- II 22. PLINY, NH III. v. 53: sed Tiberis propter aspera et confragosa ne sic guidem praeterquam trabibus verius quam ratibus longe meabilis, — — —
- II 23. VITRUVIUS II. ix. 14: propterque pondus ab aqua non sustinetur, sed cum portatur, aut in navibus aut supra abiegnas rates collocatur.
- II 24. VITRUVIUS II. ix. 16: Et ideo id castellum Larignum, item materies larigna est appellata. Haec autem per Padum Ravennam deportatur. In colonia Fanestri, Pisauri, Anconae reliquisque, quae sunt in ea regione, municipiis praebet. Cuius materies si esset facultas adportationibus ad urbem, maximae haberentur in aedificiis utilitates, — — —
- III 1. THEOPHRASTUS, HP III. x. 2: τὸ δὲ ξύλον ἢ μὲν ἐξ Ἀραβίας μέλαν καὶ φοινικῶν, ἢ δ' ἐκ τῆς Ἰθης ξανθὸν σφόδρα καὶ ὅμοιον τῆ κέδρου, δι' ὃ καὶ τοὺς πολυπόνητάς φασιν ἐξαπατᾶν ὡς κέδρον πωλοῦντας.
- III 2. PLINY, NH XVI. xxiv. 62: Materiae enim causa reliquas arbores natura genuit copiosissimamque fraxinum. procerā haec ac teres, pinnata et ipsa folio, multumque Homeri praeconio et Achillis hasta nobilitata. materies est ad plurima utilis. ea quidem quae fit in Ida Troadis in tantum cedro similis ut ementes fallat cortice ablatō.
- III 3. CATO, Rust. VII. 1: Fundum suburbanum arbutum maxime convenit habere; et ligna et virgae venire possunt, et domino erit qui utatur.
- III 4. CATO, Rust. IX. 1: Salicta locis aquosis, umectis, umbrosis, propter amnes ibi seri oportet; et id videtur uti aut domino opus siet aut ut vendere possit.
- III 5. CATO, Rust. XXXVIII. 4: Si ligna et virgas non poteris vendere neque lapidem habebis, unde calcem coquas, de lignis carbones coquito, virgas et sarmenta, quae tibi usioni supersunt, in segete conburito. Ubi eas conbuseris, ibi papaver serito.
- III 6. PLINY, NH XIII. xviii. 62: At e diverso cuci in magno honore, palmae similis, quando et eius foliis utuntur ad textilia; — — — materies crispioris elegantiae et ob id Persis gratissima.
- III 7. PLINY, NH XII. xxxviii—xxxix. 78: Haec sunt peculiaria Arabiae, et pauca praeterea communia alibi dicenda, quoniam in iis vincitur peregrinos ipsa mire odores et ad externos petit: tanta mortalibus suarum rerum satias est alienarumque aviditas. Petunt igitur in Elymaeos arberem bratum cupresso fusae similem, — — —
- III 8. PLINY, NH XII. xl. 79: Petunt et in Carmanos arberem stobrum ad suffitus, perfusam vino palmeo accendentes. huius odor redit a camaris ad solum, iucundus sed adgravans capita, citra dolorem tamen: hoc somnum aegris gauerunt.
- III 9. Corp. Iur. Civ. I, Digesta 19. 1. 17: Si ruta

et caesa excipiantur in venditione, ea placuit esse ruta, quae eruta sunt, ut harena creta et similia: caesa ea esse, ut arbores caesae et carbones et his similia.

- III 10. LIVY XXXV. 41: De multa damnatorum quadrigae inauratae in Capitolio posita, et in cella Iovis supra fastigium aediculae et duodecim clupea inaurata, et iidem porticum extra portam Trigeminam inter lignarios fecerunt.
- III 11. PLINY, NH XXIII. 64. 127: bubulas carnes additi caules magno ligni compendio percoquant.
- III 12. PLINY, NH XIX. xix. 58: Horti maxime placebant quae non egerent igni parcerentque ligno, expedita res et parata semper, — — —
- III 13. HORACE, Epist. II. ii. 167—169: emptor Aricini quodam Veientis et arvi emptum cenat holus, quamvis aliter putat; — — — emptis sub noctem gelidam lignis calefacta aënum;
- III 14. PLINY, NH XXXIV. xx. 96: fit Campano simile in multis partibus Italiae provinciaeque sed octonas plumbi libras addunt et carbone recocunt propter inopiam ligni.
- III 15. PLINY, NH XVI. lx. 141: duo genera earum: meta in fastigium convoluta, quae et femina appellatur; mas spargit extra se ramos deputaturque et accipit vitem. utraque autem immittitur in perticas asserive amputatione ramorum, qui xpi anno denariis singulis veneunt, quaestuosissima in satas ratione silva; vulgoque dotem filiae antiqui plantaria ea appellabant.
- III 16. COLUMELLA, Rust. III. iii. 3: ut primae vineae centenas amphoras iugeratim praebent, cum prata et pasqua et silvae, si centenos sestertios in singula iugera efficiant, optime domino consulere videantur.
- III 17. PLINY, NH XVI. lxxvi. 201—203: abies admirationis praecipuae visa est in nave quae ex Aegypto Gai principis iussu obeliscum in Vaticano circo statutum quattuorque truncos lapidis eiusdem ad sustinendum eum adduxit; qua nave nihil admirabilis visum in mari certum est. cxx modium lentis pro saburra ei fuere: longitudo spatium obtinuit magna ex parte Ostiensis portus latere laevo; ibi namque demersa est Claudio principe cum tribus molibus turrium altitudine in ea exaedificatis, factis ob id ex Puteolano pulvere advectisque. arboris eius crassitudo quattuor hominum ulnas complectentium imbebat; vulgoque auditur lxxx nummum et pluris malos venundari ad eos usus, rates vero connecti xl sestertium plerasque.
- III 18. STRABO XIV. ii. 24. Ὑβρῆα δ' ὁ πατήρ, ὡς αὐτὸς διηγρεῖτο ἐν τῇ σχολῇ καὶ παρὰ τῶν πολιτῶν ὁμολογήτο, ἡμίονον κατέλιπε ξυλοφοροῦντα καὶ ἡμιονῆδον· διουκόμενος δ' ὑπὸ τούτων ὀλίγων χρόνων Διοτρεφῆος τοῦ Ἀντιοχέως ἀκροασάμενος ἐπανήλθε καὶ τῷ ἀγορανομίῳ παρέδωκεν αὐτόν.
- IV 1. HERODOTUS VIII. 115: εἰ δὲ καρπὸν μηδένα εὐροειν, οἱ δὲ τὴν ποιήν τὴν ἐκ τῆς γῆς ἀναρρομένην καὶ τὸν δεινδρέων τὸν φλοιὸν περιλέποντες καὶ τὰ φύλλα καταρόποντες καθήσθηον, ὁμοίως τῶν τε ἡμέρων καὶ τῶν ἀγρίων, καὶ ἔλειπον οὐδέν.
- IV 2. ARRIAN, Indica 7.3: ἀλλ' ἀμύλισσασθαι μὲν δορὰς θηροίων ὅσων κατακταίνουεν, σιτέεσθαι δὲ τῶν δεινδρέων τὸν φλοιὸν· καλέεσθαι δὲ τὰ δένδρα ταῦτα τῇ Ἰνδῶν φωνῇ Τάλα, — — —

- IV 3. ARRIAN, Indica 11.8: Σιτέονται δὲ ὠραία καὶ τὸν φλοιὸν τῶν δεινδρέων, γλυκύν τε ὄντα τὸν φλοιὸν καὶ τρόφιμον οὐ μείον ἤπερ αἱ βάλανοι τῶν φοινίκων.
- IV 4. HERODOTUS III. 107: πρὸς δ' αὖ μεσαμβρίας ἐσχάτη Ἀραβίη τῶν οἰκομένων χωρῶν ἐστὶ, ἐν δὲ ταύτῃ λιβανωτὸς τέ ἐστι μόνη χωρῶν πασέων φρούμενος καὶ σμύρνη καὶ κασίη καὶ κινάμωνον καὶ λήδανον. ταῦτα πάντα πλὴν τῆς σμύρνης ὕσπετεως πτόνται οἱ Ἀράβιοι.
- IV 5. THEOPHRASTUS, HP IX. v. 1: Περὶ δὲ κινάμωνον καὶ κασίας, τάδε λέγονται: — — — φλοιὸν γὰρ ἐλάχιστον ἔχειν· χορήμιος δὲ οὗτος, οὐ τὸ ξύλον· δι' ὃ καὶ τὸ ἀκροφρὸν κράτιστον, κλειστόν γὰρ ἔχειν καὶ τὸν φλοιόν.
- IV 6. PLINY, NH XII. xlii. 93: Ius eius (cinnamomi) a Gebbanitarum rege solo proficitur; is edicto mercatu vendit. pretia quondam fuere in libras denarium milia; auctum id parte dimidia est incensis, ut ferunt, silvis ira barbarorum.
- IV 7. QUINTUS CURTIUS RUFUS IX. 31: Libri arborum teneri haud secus quam chartae litterarum notas capiunt.
- IV 8. THEOPHRASTUS, HP IV. xv. 1: ἐπεὶ καὶ τὸ κεράσιον περιαιρείται καὶ τῆς ἀμπέλου καὶ τῆς φιλόρας, εἰς οὐ τὰ γρονία, — — —
- IV 9. THEOPHRASTUS, HP V. vii. 5: φλόρα δὲ πρὸς τὰ σανιδώματα τῶν μακρῶν πλοίων καὶ πρὸς κιβώτια καὶ πρὸς τὴν τῶν μέτρων κατασκευὴν. ἔχει δὲ καὶ τὸν φλοιὸν χορήμιον πρὸς τε τὰ στρογία καὶ πρὸς τὰς κίστας· ποιοῦσι γὰρ ἐξ αὐτῆς.
- IV 10. ARRIAN, Anab. of Alex. II. 3.7: Ἦν δὲ ὁ δεσμός ἐκ φλοιού κεράνας, καὶ τούτου οὐτε τέλος οὐτε ἀρχὴ εραίνετο.
- IV 11. ARRIAN, Indica 29.10: Οἱ δὲ καὶ δίκτυα ἐπὶ τῷδε πεποιήνται, μέγεθος καὶ ἐς δύο σταδίους τὰ πολλὰ αὐτῶν· πλέκονται δὲ αὐτὰ ἐκ τοῦ φλοιού τῶν φοινίκων, στρέφονται τὸν φλοιὸν ὡσπερ λίνων.
- IV 12. THEOPHRASTUS, HP III. xiv. 3: Μονογενὲς δὲ καὶ ἡ κλήθρα· φύσει δὲ καὶ ὀρθοφρὸν, ξύλον δ' ἔχον μαλακὸν καὶ ἐντερμωμένη μάλαικην, ὥστε δι' ὅλον κοιλαινέσθαι τὰς λεπτὰς ῥάβδους. φύλλον δ' ὅμοιον ἀπλῶ, πλὴν μείζον καὶ ἰνωδέστερον. τραχύφλοιον δὲ καὶ ὁ φλοιὸς ἔσωθεν ἐρυθρὸς, δι' ὃ καὶ βιάπτε τὰ δέγματα.
- IV 13. THEOPHRASTUS, HP III. xviii. 5: Τῆς δὲ οὐοῦ τὸ μὲν ἄρον τὸ δὲ θῆλον καλοῦσι — — —. βάρπτον δὲ τούτῳ καὶ οἱ σκντοδέφρα τὰ δέγματα τὰ λευκά.
- IV 14. THEOPHRASTUS, HP III. ix. 1: τὸ δὲ φύλλον λεπτότερον καὶ ἀμεινρότερον ἢ παραλία καὶ λειότερον τὸν φλοιὸν καὶ εἰς τὰ δέγματα χρήσιμον.
- IV 15. STRABO XVII. ii. 4: ἡ δὲ περσέα ἐνταῦθα μόνον καὶ παρ' Αἰθιοπῶν, δένδρον μέγα, καρπὸν ἔχον γλυκύν καὶ μέγαν, — — —
- IV 16. PLINY, NH V. i. 6: — — —, per quam iter est ad montem Africae vel fabulosissimum Atlantem. e mediis hunc harenis in caelum attolli prodidere, asperum, squalentem qua vergat ad litora oceani cui cognomen imposuit, eundem opacum nemorosumque et scatebris fontium rignum qua spectet Africam, fructibus omnium generum sponte ita subnascentibus ut numquam satias voluptatibus desit.
- IV 17. THEOPHRASTUS, HP III. xv. 4: ὄρος γὰρ τῆρασι εἶναι πάμμεστον τεμνόντων, ἄλλο δ'

οὐδὲν πεφνκέναι. — — — ἐγγίγνεται δὲ τι καὶ ἠτιμωθὲς ἐν τούτοις καὶ γλίσχυρον· οὐ μὴν ἐνθευτέον γε ἡ ἠτιμὴ συλλέγεται ἀλλ' ἀπὸ τοῦ ξύλου.

- IV 18. PLINY, NH XII. xxxvi. 72: nec non et tertia in Ponto est, bitumini similior, laudatissima autem Chia candida, cuius pretium in libras *x, nigrae vero *ii. Chia e lentisco traditur gigni cummii modo.
- IV 19. HERODOTUS II. 87: ἐπεὶν τοὺς κλωστήρας πλίσσονται τοῦ ἀπὸ κέδρου ἀλείφατος γνομῶν, ἐν ᾧν ἐπλήσαν τοῦ νεκροῦ τὴν κοιλίην, οὕτε ἀνατάμοντες αὐτὸν οὕτε ἐξέλκοντες τὴν τῆσδ, κατὰ δὲ τὴν ἔδωρην ἐσηθήσαντες καὶ ἐπιλαβόντες τὸ κλύσιον τῆς ὀπίσω ὁδοῦ ταριχεύουσι τὰς προκειμένας ἡμέρας, τῇ δὲ τελευτῇ ἐξεῖσι ἐκ τῆς κοιλίης τὴν κεδρὴν τὴν ἐσθῆκαν πρότερον.
- IV 20. THEOPHRASTUS, HP IX. iii. 1—3: Τὴν δὲ πίτταν καίονσι τόνδε τὸν τρόπον· ὅταν κατασκευάσωσιν ὁμαλὴ τῶπον ὡσπερ ἄλλο ποιήσαντες ἔχουσιν εἰς τὸ μέσον συροφῆν καὶ ταῦτην ἐδαφίσωσι, κατασχίσαντες τοὺς κορυμῶς συντιθέσαι παραπλησίαν σύνθεσιν τῆς τῶν ἀνδρακενόντων, πλὴν οὐκ ἐμβοθρον· ἀλλὰ τὰς σχίζας ὀρθὰς πρὸς ἀλλήλας, ὥστε λαμβάνειν ἕως αἰεὶ κατὰ πλῆθος· γίνεσθαι δὲ φασιν, ὅταν ἡ σύνθεσις ἢ κύκλιον μὲν ὀδοφρόντα καὶ ἑκατόν πηγῶν εἰς ἑκάτον δὲ ἐξήκοντα πλείστον ἢ πεντήκοντα ἢ ἑκατόν ἀμφοτέροις, ἐάνπερ ἡ δᾶς τυχρήνῃ πλεῖρα. συνθέντες οὖν αὐτὴν οὕτως καὶ κατασκευάσαντες ὅλην γῆν ἐπιβαλόντες κατακορύπτουσιν ὅπως μηδαμῶς διαλάμνη τὸ πῦρ, ἀπολλύται γὰρ ἡ πίττα τοῦτου συμβάντος· ὑφάκτουσι δὲ κατὰ τὴν ὑπολειπομένην δίοδον· εἶτα δὲ καὶ ταῦτα εὐφράζαντες τῇ ὅλῃ καὶ ἐπιχωρῶντες τηροῦσιν ἀναβάντες κατὰ κλίμακος, ἢ ἂν ὀρθῶσι τὸν καπνὸν ὀδοφρόντα, καὶ ἐπιβάλλουσιν αἰεὶ τῆς γῆς ὅπως μὴ ἀναλάμνη, κατασκευάσαι δὲ ὀχετὸς τῇ πίττῃ διὰ τῆς συνθέσεως τῆς ἀποροφῆς εἰς βόθρον ὅσον ἀπέχοντα πεντεκαίδεκα πήχεις· ἢ δ' ὀροφεία τῆς πίττης χωρὰ γίνεται κατὰ τὴν ἀφῆν. καίεται δὲ μάλιστα δύο ἡμέρας καὶ νύκτας· τῇ γὰρ ὑστεραία πρὸς ἡλίου δύναντος ἐκκακαμένη γίνεται καὶ ἐνδεδωκεν ἢ πωρό· τοῦτο γὰρ συμβαίνει μηκέτι θεούσης, τούτου δὲ τὸν χρόνον ἅπαντα τηροῦσιν ἀγρωπυόντες, ὅπως μὴ διαλάμνη, καὶ θύουσι δὲ καὶ ἐορτάζουσιν εὐχόμενοι πολλὴν τε καὶ καλὴν γίνεσθαι τὴν πίτταν· οἱ μὲν δὲ περὶ Μακεδονίαν καίουσιν τὸν τρόπον τοῦτου.
- IV 21. THEOPHRASTUS, HP I. vi. 5: αἱ αὐταὶ δὲ διαφοραὶ καὶ τῶν φρυγανικῶν καὶ τῶν ποιωδῶν καὶ τῶν ἄλλων· πλὴν εἰ ὅλας ἐνα μὴ ἔχει, καθάρτερον ὅδον μύκησι πέζις κεραίνουσι.
- IV 22. PLINY, NH XIX. xi. 35: Lartio Licinio praetorior viro iura reddenti in Hispania Carthagine paucis his annis scimus accidisse mordenti tuber ut prehensus intus denarius primos dentes inflecteret, — — —
- IV 23. PLINY, NH XXII. xlvii. 96: familias nuper interemere et tota convivia, Annaeum Serenum praefectum Neronis vigillum et tribunos centurionesque. quae voluptas tanta tam ancipitis cibi?
- IV 24. PLINY, NH XXXVI. xxx. 138: pyritarum etiamnum unum genus aliqui faciunt plurimum ignis habentis. quos vivos appellamus, ponderosissimi sunt, hi exploratoribus castrorum

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 Libyca appellatur minima folio ac nigerrima fungisque enascentibus laudatissima.

IV 26. PLINY, NH XVI. xiii. 33: Galliarum glandiferae maxime arbores agaricum ferunt; est autem fungus candidus, odoratus, antidotis efficax,

in summis arboribus nascens, nocte relucens: signum hoc eius quo in tenebris decerpitur.

IV 27. PLINY, NH XXIV. xix. 28: Piceae et laricis folia trita et in aceto decocta dentium dolori prosunt, — — —

IV 28. COLUMELLA, Rust. XI. ii. 48: Pabulum, si facultas est, vel nunc vel etiam superioribus XV diebus, qui fuerunt ante calen. Iunii pecori praebere oportet. A cal. autem Iuniis, si iam deficit viridis herba, usque in ultimum Autumnum frondem caesam praebemus.

ACTA FORESTALIA FENNICA

EDELLISIÄ NITEITÄ — PREVIOUS VOLUMES

VOL. 86, 1968. BROR-ANTON GRANVIK.

Sahaustuloksen määrä ja laatu havutukkien kenttäpyörösaauksessa.
Summary: The Quantity and Quality of the Sawing Yield in Sawing
Coniferous Logs with Circular Saws.

VOL. 87, 1968. EINO OINONEN.

Lycopodium clavatum L.- ja L. annotinum L.- kasvustojen laajuus
rinnastettuna samanpaikkaisiin L. complanatum L.- ja Pteridium
aquilinum (L.) KUHN-esiintymiin sekä puuston ikään 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.

VOL. 88, 1968. PAAVO YLI-VAKKURI, PENTTI RÄSÄNEN ja ASKO HILLI.

Taimien talvivarastoinnista ja sen vaikutuksesta männyn taimien
istutuskelpoisuuteen. Summary: Overwinter Cold-Storage and its
Effect on the Field Survival and Growth of Planted Scots Pine.

VOL. 89, 1968. PENTTI ALHO.

Pohjois-Pohjanmaan metsien käytön kehitys ja sen vaikutus metsien
tilaan. Summary: Utilization of Forests in North Ostrobothnia and its
Effect on their Condition.

VOL. 90, 1968. YRJÖ KANGAS.

Beschreibung des Wachstums der Bäume als Funktion ihres Alters.

VOL. 91, 1968. PEKKA KILKKI.

Income-Oriented Cutting Budget. Seloste: Tulotavoitteeseen perustuva
hakkuulaskelma.

VOL. 92, 1969. MATTI LEIKOLA

The Influence of Environmental Factors on the diameter Growth of
Forest Trees. Auxanometric study.

VOL. 93, 1969. KUSTAA SEPPÄLÄ.

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

VOL. 94, 1969. ERKKI LÄHDE.

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

KANNATUSJÄSENET — UNDERSTÖDANDE MEDLEMMAR

CENTRALSKOGSNÄMNDEN SKOGSKULTUR

SUOMEN PUUNJALOSTUSTEOLLISUUDEN KESKUSLIITTO