Acta Botanica Neerlandica **12** (1963) 1–11

DISEASES AND LOPPING FOR FODDER AS POSSIBLE CAUSES OF A PREHISTORIC DECLINE OF ULMUS

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(*received October 6th, 1962*)

ABSTRACT

This paper contributes some data to the discussion about the decline of *Ulmus* in pollendiagrams from many parts of Europe at about 3000 B.C. It is shown that this decrease most probably was not caused by any known disease or pest of elm. Another explanation for the decline is lopping for fodder. Data about this industry are given from recent and historical times, from Europe as well as from the Himalayas. Lopping is a common phenomenon, essential to husbandry in many places. It may even lead to local extermination of a species. *U. glabra* might be affected more than *U. carpinifolia.*

INTRODUCTION

In pollen diagrams from western, central and northern Europe, an important decline in the percentage of *Ulmus* can be observed around 3000 B.C. In some areas this decline coincides with a decrease of *Hedera helix*, which might have been caused by a climatic change (IVERSEN, 1941, 1960). Palynologists often interpret the decrease of these species as an indication that at this point the Atlantic period gave way to a colder or more continental climatic period, the Subboreal.

Now, it is easily conceivable that *Hedera*, being badly adapted to our climate, should diminish in the course of colder winters. Likewise, it can be argued that a colder climate might have caused the northern limit of the area of *U. carpinifolia* Gled. *sensu* Rehder to retire some hundred kilometers down to its present position in Sleswick-Holstein. This could explain the decrease of *Ulmus* in Denmark at least. However, there is no direct evidence for the occurrence of *U. carpinifolia* in Denmark during the Atlantic, since its pollen cannot be separated from that of *U. glabra* Huds., which species is still there. So, it may be that the decrease around 3000 B.C. was a decrease in *U. glabra*, but it is not clear why such a frosthardy species should be affected by a colder climate.

Outside Denmark, the climatological explanation of the decline of *Ulmus* has to meet even stronger objections. That applies for example to Norway, where only *U. glabra* has to be reckoned with, and where less hardy species as *Hedera* and *Fraxinus* sometimes show a simul-

taneous increase (HAFSTEN, 1956; FAEGRI, 1940, 1944). The case is similar in Ireland and in other areas, where the fall of *Ulmus* is not attended by a decrease of Hedera (VAN ZEIST, 1959).

For this reason, the fall of *Ulmus* has aroused much discussion lately. Some palynologists wonder what role some disease or parasite of elm might have played (e.g. SMITH 1960); others think that prehistoric men might be responsible to some degree (NORDHAGEN in FAEGRI 1940, TROELS-SMITH 1953, 1955, 1960, IVERSEN 1960). This paper intends to furnish more data to this discussion. The author, being a forest pathologist and a selective breeder of elms, will refrain from drawing conclusions in palynological questions.

THE ELM DISEASE

Native pests and diseases generally have a remarkably small influence on the composition of more or less natural vegetations. Introduced diseases on the contrary may annihilate the susceptible species. Circumstantial evidence indicates that the elm disease (sometimes called Dutch elm disease) belongs to the second group; its introduction in Europe probably dates back to the first or second decade of this century.

The elm disease is a wilting disease, caused by the fungus *Ceratocystis ulmi*, syn. *Ceratostomella ulmi*. The fungus lives in the vessels of the current annual ring, where it causes a brown discoloration. Directly or indirectly it interferes with the sapstream, so that the crown of the tree wilts and often dies. In Europe, it is carried to healthy trees by the elm bark beetles *Scolytus scolytus* and *S. multistriatus*.

The disease was first recognized in 1919 in the southern part of the Netherlands and perhaps in 1917 in northern France (WESTENBERG, 1932). Apparently from this part of western Europe as a centre, the disease spread in an explosive way in the following years. In most places, it was recognized as an entirely new phenomenon. In France, it was found only in the area north of the Seine in 1922, but afterwards it spread over the whole of the country (SPIERENBURG, 1922). In Holland, in a few years hundreds of thousands of elms were killed. In northern Italy, varieties of elm, which had been used to provide trees as living supports in viticulture for generations and perhaps for millennia, suddenly succumbed under the disease. As far inland as in central Asia, centuries-old and cherished cultivated varieties of elm, suddenly started to die from this disease in increasing numbers from 1939 onward (ROVSKI, 1956). About 1929, the disease crossed the Atlantic on elm logs and started to kill American elms in great numbers.

These data may suffice to show that the disease is a new phenomenon. Some authors found discolorations in annual rings of elm which were formed as far back as 1900 (LIESE 1952) or at the end of the 19th century (ROVSKI 1956). From this evidence they derived that the elm disease might have been present in Europe in earlier days. This reasoning does not necessarily hold, however, since discolorations of this sort may arise from other causes as well. SPIERENBURG (1929),

searching for historic evidence, could not find any indication for the occurrence of the elm disease in former days. DUHAMEL DE MONCEAU (1768), a keen observer, noted two different types of disease in elms, in a few places, but nothing like the elm disease.

In human pathology, epidemics may have an outbreak and disappear again, only to come back after a long period. The elm disease cannot be compared to such human disease. Like the rabbits in Australia, it is there to stay when it once has taken foot on a new continent.

At present, the elm disease is reported from nearly all European countries. It does not occur in Finland and Norway and it is very rare in Denmark and Scotland, probably because the carrying beetle is absent or rare in those countries. There is no reason to suppose that it would have been common in Norway formerly. Moreover, if the disease had been present in Europe for 5000 years one could expect a reasonably high level of resistance to the disease in the remaining elm populations. That is not the case: resistance is a very rare property in all European elm populations that have been tested (WENT 1953).

In conclusion, one can safely discard the hypothesis that the elm disease could have anything to do with the decrease of elms around 3000 B.C.

OTHER DISEASES

There is one more epidemic fatal disease of elm known, the phloem necrosis. This is a virus disease, which is carried by the cicadelide *Scaphoides luteola*. Around 1870, the disease seems to have caused a very serious epidemic in *Ulmus americana* in Kentucky, U.S.; the few remaining elms appear to be resistant to the disease. Following a slight general increase in temperature, the insect has expanded its area to the North, so that phloem necrosis is serious in a part of Indiana now. Amongst the European elms, only *U. laevis*, which is nearly related to the American elm, seems to be susceptible. The carrying insect does not occur in Europe. There is no reason to suppose that the disease ever did occur in Europe.

Enormous numbers of elms have died in the low-lying forests along the rivers Elbe, Donau and Save this century. The causes have not yet been completely elucidated; see e.g. LIESE (1952). It seems certain that, next to the elm disease, a lowering of the watertable through canalization of the rivers played a decisive role. These forests consist mostly of oak, elm and ash. In them not only elm, but also ash and even oak may suffer under these conditions. It seems that grown trees cannot adapt themselves to a lower watertable and therefore die; young trees, however, can grow vigorously under the new conditions at the same spot. Therefore it is unlikely that a similar incident could have had more than a local and temporary effect in prehistoric times.

In some cases, elms seem to have been killed by the single action of the beetle *Scolytus scolytus*. However, this may happen only if the

tree was in a poor condition before, and if the number of beetles is unusually high. Moreover, the species is absent in N. Europe.

Given the competition of other trees, a gradual decrease of the proportion of elm in the vegetation could be brought about by a disease or pest even if it did not kill the trees, but only reduced their vigour. We cannot suggest any organism that might be responsible for even such a relatively minor change.

Therefore, for the moment diseases and parasites can be ruled out in explaining the fall of the *Ulmus*-curve. In trees that are lopped however, several diseases and parasites may assist in shortening the trees' life, e.g. slimeflux, *Nectria cinnabarina*, *Polyporus squamosus*, *Cossus cossus*.

Lopping in the Himalayas

In autumn 1960, the author made a tour through the lower parts of the Indian Himalayas, in order to collect living material of elms to be used in breeding disease-resistant elms for forestry purposes in Holland and other countries. During this tour, he was impressed by the extent to which leaves from different trees, but notably elm, were utilized as cattle fodder. Some of the information collected might be of interest to palynologists.

Ulmus

Four species of elm have to be considered. Most important is the large-leaved elm *Ulmus wallichiana*, a tree that can be compared to our *U. glabra* Huds. It grows at higher altitudes than the other three, mostly between 2000 and 2700 m over sea level, occasionally up to 3000 m. At lower altitudes and mainly east of the river Sutlej an unnamed species can be found which could be compared to a small-leaved *U. carpinifolia*. At the same lower altitudes, but generally west of the river Sutlej, *U. villosa* occurs, a species that stands isolated in the genus and thus has no counterpart in Europe. The fourth is a tropical, evergreen elm, *U. lancifolia*, whose area extends from Nepal to Sumatra; the author saw it only in the Tista valley near Darjeeling. All species are in high esteem for fodder.

Except in two cases, all visited trees of *U. wallichiana* which could be climbed were lopped for fodder. The first exception was found in the game reserve Dachigam in Kashmir, which is closed to the population. The second was a single tree in the village Kolung, Kulu valley, which might have been a sacred tree. This lopping was so intense that it had a major influence on the occurrence of flowerbuds, which will not develop on watershoots which are produced on recently lopped trees. In Kashmir, trees with flowerbuds were seen in the game-reserve Dachigam only; all other trees of this species had non-flowering watershoots. In the Kulu valley, apart from the Kolung-elm, some elms that grew on completely inaccessible cliffs were not lopped and thus had flowerbuds. In the upper Sutlej valley all visited large-leaved elms were lopped. In Dehra Dun district one tree in the village of Konain which had not been lopped for more than 5 years, bore some

flower-buds, as did two trees in a very remote corner of Riknar-forest.

The second species, which was mentioned above as being related to *U. carpinifolia*, more often escapes lopping. In Mussoorie, where the tree is not uncommon, one heavily lopped elm of this species was observed amidst a forest of untouched oaks. In Chaora in the Sutlej valley, where one small lopped specimen was encountered, the species was not well-known to the villagers. A man from Nepal however immediately recognized the plant, gave it the correct vernacular name and described it as a small tree, lopped for fodder in Nepal.

U. villosa is valued for its fodder too, but many specimens are sacred trees, others are planted in sacred places or for ornamental purposes, in which cases they are not lopped.

Of *U. lancifolia* only three individuals were seen, growing in luxuriant tropical forest in a wet climate. Even here, two trees had been lopped; the third, an unclimbable one, was untouched.

The influence of lopping is profound, especially on the large-leaved elm. The tree is often severely damaged, so that rots may enter through the wounds and shorten its life. In a mixed forest, the elms' neighbours are relatively favoured and eventually will overgrow the elm. Worst of all, the tree is prevented from producing pollen and seeds. Thereby it is now being exterminated in the wild in those areas, where it is not fortunate enough to find a refuge on inaccessible cliffs or in a game-reserve. A single tree, e.g. a sacred one, may not suffice to perpetuate the species, since elms generally are self-sterile.

So far, a very destructive way of lopping was discussed. It occurs at some distance of habitation and the fodder seems often to be eaten at the spot by the animals of wandering shepherds. With their small but longshafted axes, these are experts in climbing the highest trees (Plate 1, 2). Near the villages, however, lopping is carried out in a much more careful way, forming a more or less complicated framework of branches for sustained yield of fodder. Twigs are dried and often stored in forks of the tree, to be collected in winter. This fodder seems to be essential for overwintering the cattle, since hay is scarce. Therefore, trees are often planted near villages for this purpose (Plate 3, 4). The large-leaved elm was present in numbers in and around the villages of Baba Reshi and Phraslun (Kashmir), Shanag (Kulu valley), Konain (Dehra Dun district) and in Panchhot Khad, Sutlej valley; moreover, they were found scattered in a great many villages. They are still being planted. A nice example of this was seen near a farm-yard in Kothi, where three young trees of apricot, peach and elm were planted side by side: the fruits for men, the elm for the cows. The young elm had been procured from the forest.

The cycle of lopping seemed to be rather short; mostly 2–3 years, sometimes longer, in one case 1 year (Plate 4).

Being exterminated in the forest and planted in the villages, the elm is becoming a cultivated species. We cannot yet say whether any selection has occurred in this process.

Other tree species

In only a few places does elm play quantitatively a major role in the lopping industry. Where *Celtis* and *Morus spp.* thrive, which is mostly at somewhat lower altitudes, these seem to be preferred. They may have proceeded further on the way to cultivation. On this excursion, they were not seen in the wild state, though they may have been overlooked somewhere. *Salix alba* is widely cultivated for the purpose in Kashmir, even at higher altitudes, e.g. in Phraslun at about 2500 m. *Juglans regia, Fraxinus excelsior, Aesculus indica, Acer spp., Parrotia jacquemontiana, Prunus padus* and others are regularly lopped, though they seem not to be preferred over *Ulmus*. The oaks are lopped widely; they form vast forests and have the advantage of being evergreen, so that they can be taken in winter. Quantitatively, their role is so important that most forestry literature is centered on the oaks; qualitatively, they seem to be inferior to elm. We never saw *Alnus nitida* being lopped, so that it seems to be useless as fodder; the same applies to *Populus ciliata*. Sometimes, even *Taxus baccata* is lopped for fodder.

At higher altitudes, *Betula utilis* seems to be devastated by the shepherds for providing fresh leaf-fodder (DUTHIE 1894). A valley near Tanin, Kashmir, which was covered with lopped birches in Duthies' days (l.c., p. 27) was a treeless pasture in 1960.

The importance of lopping in many areas can be judged from the following citation from a study on the hill area of Uttar Pradesh, where abundant grass is available during the monsoon (15th June–15th October) only: "Without leaf fodder, animal husbandry would be out of the question, and its importance in the hills can scarcely be overestimated" (ANON. 1947, p. 121).

LOPPING IN EUROPE AND THE NEAR EAST

BROCKMANN-JEROSCH (1918) reports from the upper Rhine valley in Switzerland, that leaves of elm were used not only as winter-fodder for goat, sheep and cow, but also, fresh or dried, as a special fattening fodder for pigs. Petrus Hondius (cited by DODONAEUS, 4th ed.) observed in Anjou, France, that elm leaves were collected in bags, dried and stored to be used for fattening pigs in winter. The same is reported from Herefordshire, England, by EVELYN (1664). CHEVALIER (1942) cites OLIVIER DE SERRE (1600), who, speaking of the Cevennes, holds that fodder of elm and ash is a delicacy, eaten by cow and goat as eagerly as oats. VE (1930), discussing leaf-fodder conditions in a valley in W. Norway, cites the farmers' proverb: "raun føder, alm gjøder": rowan nourishes, elm fattens. Scientific analysis confirms these farmers' views on the nutritive value of elm: in the tables of WOODMAN (1945) dried elm leaves attain a nutritive index ("starch equivalent") of 50.0, comparable to very good lucerne hay (37.1) and very good meadow hay (48). RUSSELL (1947) finds for elm a starch equivalent of 64, the highest of all leaves, for birch 37–41, for very good hay 57.

Even then, lopping for fodder has always been carried out primarily in the poorer parts of Europe, by the poorer families, or mainly by children and elder people. In the Lungau, Austria, around 1650 it was the immigrated and therefore landless miners who for their goats depended on leaf fodder (pers. comm. Forstmeister MÜHLBAUER, Mauterndorf). In Yougoslavia, PETROVIĆ (1936) assumed that 1.000.000 ha of forest, mainly of oak, was in use as "Futterlaubwald" or forage-forest, in the poor parts of the country. In his paper, he gives directions for the management of such forest. He deciphers that the yield of 1 ha of coppice, cut at the end of a rotation period of 4 years, suffices for overwintering 40 sheep, given a feeding period of 90–150 days. In that way, over the years, every 10 sheep need the production of 1 ha. Cows need 5–6 times as much as sheep. For the karst-areas of N. Yougoslavia, WESSELY (1876), BUBERL (1895), MARHULA (1884), GESCHWIND (1917 and 1920), give instructions for the planting and care of new forage-forests. For Turkey, LOUIS (1939) mentions "rücksichtslose Holzentnahme, Beweidung durch Ziegen und Laubentnahme zur Streckung des Winterfutters" as the causes for the deterioration of the mixed summergreen oak-forests.

For Iran, BOBEK (1951) gives a photograph of trees lopped for fodder around a settlement in the forest. In Spain, NORDHAGEN (1954) saw elms in numerous roadside plantations; not one tree was unlopped. BOLAÑOS (1960) remarks: ". . . follaje de plantas leñosas y subleñosas, ya que en la mayor parte de los casos no sólo tienen importancia, sino que constituyen la base nutritiva".

From Italy the use of elm and ash is well documented by the classics as well as in modern times (GOIDANICH, 1937). In France this use is reported from the Mediterranean and from the Basque coast (PEES, 1960, p. 395), as well as from the Vosges and Auvergne, in which last two areas the author found that the practice was discontinued after the first and second world war respectively.

For northern Europe we have the reports of VE (1930), NORDHAGEN (1954) and others (see TROELS-SMITH, 1960) for Norway and that of RANCKEN (1953) stating that ash is still being lopped for fodder in Sweden.

Though the utilization of leaf fodder is well documented up to these days both from the Alps with adjacent areas and the Scandinavian peninsula („diese kulturelle Reliktlandschaften", GUYAN, 1955) reports on this practice are absent or very old and scarce for the zone of Europe in between. Leaf fodder in general and fodder of elm in particular seems not to have played a more than accidental role in recent centuries here. Lopping is not a sure indication of utilization of the leaves as fodder. Even in Normandy and Brittany, where elms are lopped or pollarded for fuel regularly and on a large scale, the leaves are not given to the cattle. Pollarded elms in England which were mentioned by PRICE (1786) yielded twigs for fuel only. Elms were expressly planted to be pollarded for fuel on a four-years rotation in the province of Brabant, Belgium, in the 16th century (DODONAEUS, 3rd. ed., 1609). The same author as well as DE LOBEL (1581) did

state that cows like elm leaves and produce a good butter and a rich dung from them; yet it may be doubted that these statements reflected the agricultural practice of the Low Countries of their days, since the authors were anxious to agree with Columella and Theophrastus. On the contrary, a close study of the first and second edition of DODONAEUS (1554 and 1563) strongly suggests that feeding elm-leaves was unknown or rare in the southern Netherlands in his days.

Positive reports from Britain do exist. Though GERARDE's "Herball" (1597), being largely based on DODONAEUS, must be doubted on the same ground, we may trust MASCALL (1633) who recommends elm leaves for fattening oxen. Also EVELYN (1664) sounds authentic: ". . . finally, which I must not omit, the use of the very leaves . . . is not to be despised; . . . suffered to dry upon the branches . . . they will prove a great relief to cattle, in winter and in scorching summers, when hay and fodder is dear: they will eat them before oats, and thrive exceedly well with them".

Up to now, we have not found the practice mentioned for these areas in the last 3 centuries. In passing, it might be noted that ash has played an even smaller role than elm in providing fodder in this zone of Europe. Its utilization is not mentioned by either DODONAEUS, DE LOBEL or GERARDE. EVELYN only says: "The very dead leaves afford, like those of the Elm, relief to our cattle in winter", but the editor of his 1776-edition warns against ashes near pastures, "for if the cows eat the leaves or shoots, the butter will become rank and of small value". This being so, it is curious that elm seems not to have played an important role in European plantlore. For the Ainu people in Japan, elm was the first tree that was created by the gods; but no such stories are known here, Yggdrasyl being an ash.

We do not know much about the distance that farmers were prepared to go for collecting fodder. This range of action of a village may have been wide. In the Lungau in Austria, spruces were lopped for litter till about 1920. The farmers used to cut the twigs in summer, and carried them home on sledges in winter. The traces of this practice can still be found in the living trees in the form of overgrown branch-stubs. Such trees occur very far from habitation, up to distances which could just be covered with a horse-drawn sledge in going and coming in one day (pers. comm. Forstmeister MÜHLBAUER, Mauterndorf).

CONCLUSION

In 1947, the joined Imperial Agricultural Bureaux in Great Britain edited a publication with the significant title: "The Use and Misuse of Shrubs and Trees as Fodder" (ANON., 1947). It opens as significantly: "It is a humbling fact for grass pasture experts to realize that probable more animals feed on shrubs and trees . . . than on true grass or grass-legume pastures . . .". It appears that grass and especially hay as a fodder are in use mainly in the more fortunate climates or in the more technically advanced parts of the world. Even there,

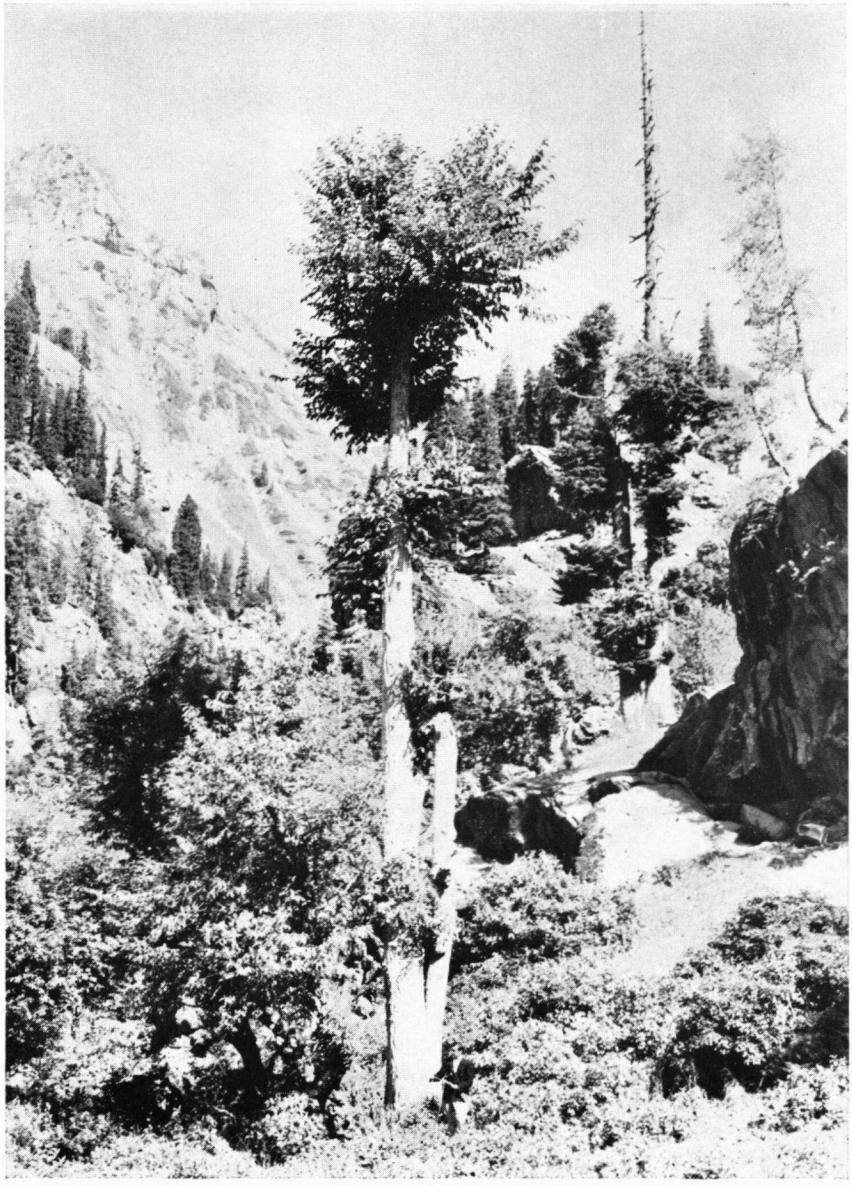

Plate 1 and 2. Destructive way of lopping in *Ulmus wallichiana* in the forest, Kashmir. In plate 2, a small section of the crown of a big tree is shown. A shepherd is lopping with a light, longshafted ax.

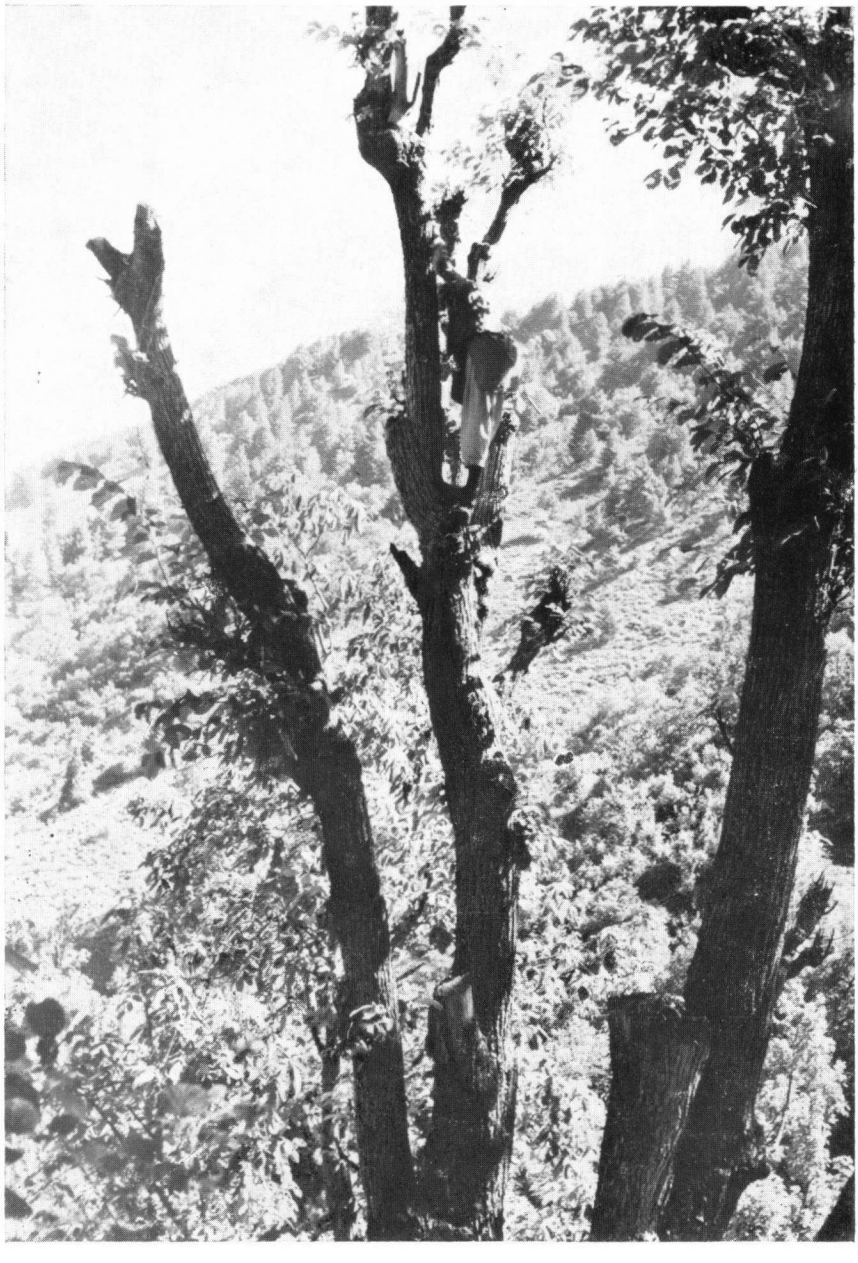

Plate 2. (See plate 1.)

Plate 3. *U. wallichiana* planted in numbers for permanent production of fodder around the village of Konain, U.P.

Plate 4. *U. wallichiana* near village of Shanag, Kulu valley, Punjab, 30 September, 1960. Lopping in these trees is carried out annually, on a permanent basis. The right-hand tree is just treated, the others will follow.

however, in unfavourable months or years the farmers may have to fall back on leaves or leaf hay as an emergency-fodder, as the case was in several parts of Europe during the second world war. Therefore, it needs no excessive imagination to presume that leaf-fodder played a bigger role during some prehistoric periods. Lopping in a given area over a short period will drastically restrict the formation of flowerbuds of elm and thus decrease the percentage of elm pollen in the pollen-rain without reducing the number of elm trees in the forest. This reaction will be common to both wych elm (*Ulmus glabra* Huds.) and field elm (*U. carpinifolia* Gled. sensu Rehder). When lopping is continued over the centuries, however, some difference between the species may become apparent. For its reproduction, wych elm depends mainly on its seeds, so that it may be eradicated locally by lopping, in the same way as *U. wallichiana* is being exterminated in Kashmir. Field elm, on the other hand, regenerates profusely from root-suckers, which capacity might be strenghened rather than weakened by lopping. This results in a dense young growth which may not contribute to the pollen-rain, but which will hold the ground for this elm till better days.

Both ash and elm, being preferred for fodder, will suffer from lopping. Because ash shows a shorter delay of flowering after lopping (VE, 1930), this will result in a much smaller decrease of the share of this tree in the pollen-rain; likewise, its seed production will be less affected. Moreover, ash seedlings are more easily established than those of elm. Therefore, elm will suffer much more from indiscriminate lopping than ash, and wych elm more than field elm. In case the early farmers started protecting or encouraging young growth of their precious fodder-trees (which possibility seems not to be excluded), this might lead to an increase of *Fraxinus*, even beyond its original level, whereas *Ulmus* would normally not profit by it (see, however, TROELS-SMITH, 1960, Plate VI).

ACKNOWLEDGEMENTS

Thanks are due to dr. W. van Zeist, Groningen, who gave the impetus to this publication and provided the palynological background; to Mr. R. H. Richens, Cambridge, for providing some English references, and to dr. F. W. Holmes, Amherst, Mass., U.S.A., for correcting the English text. The Himalayan tour was made possible by a grant from the Pieter Langerhuizen Lambertuszoon-fonds, Haarlem; additional help came from the Johanna Westerdijk-fonds, the M. P. Löhnisfonds and the Longwood foundation. The Government of India was most helpful in many ways.

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