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SCIENCE AND CIVILISATION IN CHINA

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JOSEPH NEEDHAM

SCIENCE AND CIVILISATION IN CHINA

VOLUME 6

BIOLOGY AND BIOLOGICAL TECHNOLOGY

PART III

AGRO-INDUSTRIES AND FORESTRY

AGRO-INDUSTRIES: SUGARCANE TECHNOLOGY

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he meant a fall in precipitation, had caused the collapse of Chinese power in Central Asia during the medieval period.[a] W. G. Lowdermilk, on the other hand, believed that deforestation and erosion alone could account for the apparent decline of agricultural productivity in north China.[b] In 1935, V. K. Ting questioned the assumption of a consistent deterioration of the climate of north China, showing that the incidence of floods and famines is not correlated statistically with changes in rainfall.[c]

The influence of forests on climate is still poorly understood. A distinction must first be drawn between localised effects, and regional, or even global, effects. Trees moderate their immediate environment. Deforestation can therefore alter micro-climates and hamper regeneration in harsh climates, a significant factor in north China. The functions of forests in regulating climate on a large scale are not so clear. We know that water is recycled into the atmosphere through evapotranspiration, but research is only beginning to evaluate how far it is carried before it condenses and falls again as rain.[d] It is not yet possible to decide whether climatic change in north China is the result of deforestation, or whether it is related, instead, to worldwide changes in climate.

There is still no conclusive evidence to support the assumption, central to the thesis of dessication, that the loess plateau was originally well forested. Early settlements such as Pan-Pho[1] near Hsi-An[2], Shensi province, were located near the ecotone between the western grasslands and the eastern woodlands. There is no doubt that trees were present at these sites, since excavations show that poles were used in building and wood ash from midden fires has been found. It is also accepted that most of the burden of silt carried by the Yellow River is soil eroded from devegetated hillsides in the loess plateau.[e] The conventional interpretation of these observations is that the whole of this region was originally well forested. Settled agriculture began in the river valleys and gradually spread up the hillsides, exposing the friable loess soils to erosion, starting the cycle of siltation and flooding.[f]

Five main forms of evidence have been used to support this scenario. They are literary records, archaeological excavations, palynology, palaeontology and the study of relict vegetation such as protected temple forests. Caution is needed, though, in using each of these sources. They tell us that there were trees on the north China plain and the loess plateau. They do not tell us

[a] Huntington (1).
[b] Lowdermilk (4), and (1).
[c] Ting (1).
[d] Lockwood (1), ch. 6, is a summary of current knowledge of the role played by forests in regulating climate.
[e] There is geological evidence, though, that there was some siltation in the Yellow River before any human settlement had taken place. See Wang Yung-Chhüan[3] (1).
[f] A number of papers and forest histories written recently in China have followed this interpretation. Cf. Ling Ta-Hsieh[4] (1), Chang Fan[5] (1), and Chang Chün[6] (1).

[1] 半坡 [2] 西安 [3] 王勇泉 [4] 凌大燮 [5] 張帆
[6] 長軍

whether trees dominated the ecosystem, or whether they were just one component in a more complex system including grasses, shrubs and brush. References to trees in the *Book of Odes* (*Shih Ching*[1]) indicate the presence of certain species, so far as they can be identified, but tell us very little about the appearance of the landscape during the Western Chou period (c. −1045 to −771) when most of the poems were composed.[a] It is reading too much into the text to say, for example, that because a poem describes a tree being felled, this indicates that the area was densely forested.

Archaeological evidence shows that wood was used in the neolithic societies, but it is wrong to assume that a densely forested environment is necessary for wood to be used as a building material. Shih Nien-Hai[2] justifies his assumption on the grounds that 'in those rough and pioneering times, communications were still undeveloped, and timber is bulky making it difficult to fetch it from a distance, so it had to be brought from nearby locations.'[b] This might be true for large timber, but the poles used in the construction of huts could be carried to the village from scattered trees a short distance away, and it would be equally plausible to hypothesise a savannah-like landscape with scattered trees in association with shrubs and grassland.

The presence of tree pollen at archaeological sites again confirms the presence of trees, but existing data do not give a very clear idea of their spatial distribution. Caution is needed in using palynological evidence. Settlements are generally located close to a permanent supply of water, where riparian vegetation with more trees would be expected. Cores drilled in the course of recent geological research in the loess plateau, at some distance from known settlements, contain very little tree pollen after the deposition of the loess mantle during the Quaternary.[c]

The available evidence does not warrant the generalisation that the primitive landscape of north China was uniformly forested. Dense jungle, savannah grassland interspersed with trees, and grassland with riparian forest are just three of many possible forms of forest cover. It has been said, for example, that the representation of animals such as the rhinoceros and the tiger in the bronzes of the Shang and Chou periods is confirmation that dense forest covered the area controlled by the early Chinese State. The habitat of the rhinoceros is open woodland and grassland while the tiger requires some dense cover for its lair, but hunts in woodland and grassland.[d] Scrub and brush which may have been im-

[a] Kêng Hsüan[3] has identified most of the common plants and trees in the *Book of Odes*. See Kêng (1).
[b] Shih (1), p. 234. All translations in the text and footnotes are my own, unless otherwise indicated.
[c] Shensi Geological Research Institute (1), chapter 3, 'Stratigraphy'. Pearson (1), p. 227, adds a further warning that loess soil is 'a notably poor environment for the preservation of pollen grains' and that the shrubby genus *Artemisia* may be over represented in samples because its pollen survives better than most arboreal pollens.
[d] The gazetteer of Lin Hsien[4], Ho-Nan province, reported in 1752 that the county had no forest, but it also said that there were problems with tigers in the mountains. +1752 *Lin Hsien Chih*[5], ch. 5, p. 19b.

[1] 詩經 [2] 史念海 [3] 耿煊 [4] 林縣 [5] 林縣志

portant components of the vegetation provide suitable habitat for both these species.

A careful reading of the literary sources suggests that the vegetation cover of the north China plain and the loess plateau was not uniform. The economic reforms proposed for the State of Chhin[1] by Shang Yang[2] (d. −338), included a section concerning land-use planning. If these reforms had been fully implemented, both forest and grassland would have been recognised as categories distinct from agricultural land,[a] which suggests that both vegetation types were significant features of the landscape at the time. Poems in the *Book of Odes* distinguish between the trees which grow close to rivers, and the trees on higher ground.[b] At still higher elevations, conifers are usually referred to as being found in the mountains.[c]

The availability of water is the most important factor determining the distribution of vegetation in the semi-arid climate of north China. Sites subject to water stress, such as south-facing slopes or rocky ridgetops, support sparser forest than the cooler, more mesic sites. A recent survey showed a distinct difference in the distribution of species and density of forest cover on north- and south-facing slopes in the mountains outside Peking.[d] To the west, where the climate is drier, the importance of aspect is even more apparent, with grassland on south-facing slopes, and woodland on the north-facing slopes (Fig. 117).

The picture of the original landscape of north China which emerges from these observations is neither of dense forest nor of a barren steppe, but rather of a mosaic of vegetation. There was fairly thick forest around rivers and other permanent sources of water. The plains were probably covered in rather sparse deciduous woodland, opening out to savannah grasslands with scattered trees or brush in the northwest, in what is now northern Shensi province, and most of the Ordos plateau of Inner Mongolia. Denser deciduous woodland was found on the foothills of the mountains, with scrub and brush or drought-tolerant species on south-facing slopes. Coniferous forests dominated the higher elevations above about 1,500 metres with larch and spruce forming the highest forests just below timberline.

(3) Vegetation Changes: the Pattern of Deforestation

Tracing the progress of deforestation requires searching through historical and literary sources for any mention of forests, of scarcity of timber, or for informa-

[a] *Shang Chün Shu*[3], ch. 4, *Lai Min*[4], p. 27.
[b] Cf. *Thang Fêng*[5], *Shan Yu Shu*[6], Karlgren (14) no. 115, p. 74. Also *Chhin Fêng*[7], *Chü Lin*[8], Karlgren (14) no. 126, p. 80.
[c] This is particularly noticeable in the descriptions of mountains in the *Shan Hai Ching*.
[d] Lin Chhao[9] & Li Chhang-Wên[10] (*1*), p. 22.

[1] 秦 [2] 商鞅 [3] 商君書 [4] 徠民 [5] 唐風
[6] 山有樞 [7] 秦風 [8] 車鄰 [9] 林超 [10] 李昌文

Fig. 117. Vegetation distribution. *Picea asperata* forest in Kan-Su; from Wang Chi-Wu (*1*), opposite p. 62.

tion on land use. Shih Nien-Hai[1] has carried out the most detailed survey of this kind in his work on the geography of the middle Yellow River region.[a] A regional study has also been made by Chhên Chhiao-I[2] of the area of the Yangtse estuary, with particular reference to the Hui Chi[3] mountains of Chekiang province.[b] Wên Huan-Jan[4] has published one of the few serious attempts to date to follow the changes in forest cover over the whole of China, relating periods of forest destruction to factors such as periods of war and rebellion, internal migration, and changes in agricultural technology.[c] These three sources have been essential references in preparing this outline of changes in the forest cover of China.

(i) *Northeastern and northern China*

The earliest archaeological sites in the northeastern boreal forests have been dated to the period between −1000 and −2000. Ashes and birch bark found at these sites indicate that hunters and gatherers used the resources of the for-

[a] Shih (*1*), pp. 232–313, Shih (*2*).
[b] Chhên Chhiao-I (*3*).
[c] Wên (*1*).

[1] 史念海 [2] 陳橋驛 [3] 會稽(山) [4] 文煥然