Changes in the Landscape and Vegetation Under the Influence of Prehistoric and Historic Man in Central Europe

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Richard Pott

Abstract

This paper is dedicated to Holocene forest history with a special focus on prehistoric and historic human impact. As the original landscape is turned into cultivated land, humankind's influence on the evolution and formation of central Europe's cultivated landscapes is of major importance.

Today's central European woodlands are the result of utilization and forest change over centuries, locally even millennia. The central European climate is conducive to tree growth and all of central Europe would be a more or less monotonous woodland now if human beings had not created cultivated landscapes with their meadows, pastures and fields, continually pushing the forests back over recent centuries. This paper will focus on whether or not there would have been forest-free habitats of any significant size in the areas covered by deciduous and coniferous forests, that were created and cleared by herds of animals as open landscapes, in addition to the naturally forest-free habitats.

Keywords

History of forests • Ancient woodlands • Megaherbivores • Human impact

4.1 Introduction

Central Europe only has a few landscapes left that still appear natural. These are the coastal regions with their tidelands, dune complexes and a number of ungrazed salt marshes. Further inland, they include some riverscapes and a small number of

R. Pott (✉)
Institute of Geobotany, Leibniz Universität Hannover, Hannover, Germany
e-mail: pott@geobotanik.uni-hannover.de

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inland waters with their covers of floating leaves, reeds, and swamp forest complexes. And then there are also a number of xerothermic vegetation complexes on natural rock habitats, and the grass, scree and rock formations at the alpine levels of our higher mountains.

Almost all other areas have been cultivated, changed or at least temporarily used or moulded by human beings for quite some time. Even the once vast, nutrient-poor upland moors have been reduced to a small number of near-natural landscape elements in some conservation areas. Extensive moors are still to be found in the Baltic region and the north of Russia.

Today's forests, also, are the result of centuries and sometimes millennia of use and silvicultural transformation. We are living in a highly cultivated landscape. The attributes "virgin", "natural", "cultivated" and "industrial" derive from the various uses specific sections of the landscape are put to today. What is often forgotten in the process is that apparently natural landscapes with their characteristic ecosystems have also been subjected to steady natural change for many thousands of years. The term "wilderness" is frequently used of late to describe biotope types that are unclaimed by man. Mudflats and islands, lakes and brooks, forests and moderately used meadows and heathlands with their hedges and bushes have hence come to epitomize intact landscapes for many because they often feature a great variety of biotopes in the smallest of spaces.

Such elements are invariably part and parcel of central Europe's cultivated landscape, however, having undergone various different developments in time and space, depending on their endowments as natural regions. The central European climate is conducive to tree growth, and all of central Europe would therefore be a more or less monotonous woodland now if human beings had not created today's cultivated landscapes with their meadows, pastures and fields, pushing the forest ever further back over the course of recent millennia. Only the salty marshes, the windswept and salt-affected coastal dunes, the ombrotrophic, rain-fed hill moors, some low moors, a number of xerothermic vegetation complexes at rocky ridges and rock waste screes, the avalanche paths and alpine regions above climatic timber lines are free from forest by nature, along with some relatively short-lived beaver meadows in the riparian zones. This has also been known for many years from a great number of vegetation history studies (Pott 1993, 1997, 2003).

We are therefore living in a highly cultivated landscape and can hardly imagine what it looked like before, or what it would look like today if people had not intervened in it for thousands of years. This impact of human beings on the vegetation and natural environment in the course of the landscape's prehistoric and historic changes is to be examined in greater detail under various aspects by this essay.

4.2 Cultivated Landscape: What Is It?

Everything designed by human beings is culture. This includes artworks as much as farmed land, the landscape. Nature develops in various landscapes: the growth and decline of living things shapes and changes the land. People influence landscapes by their activities, by cutting down forests, creating fields and pastures, by letting their domestic animals graze in the forest or grasslands. All this is connected with the daily work and practices of land users. The notions of landscape in literature, paintings and the landscape-describing arts are meanwhile often idealized: landscapes are perceived as beautiful, as a paradise or Arcadia, they appear Mediterranean or like a Switzerland, or remind us of England. Landscape is constantly informed by nature, mostly by human agency, and always by ideas. Everything is contained in the "total impression of an area" Alexander von Humboldt spoke of (Humboldt 1845). Today, we need to modify this "total impression": landscape can be viewed subjectively, abstracted objectively, and penetrated intellectually. Its spatiotemporal perspective remains an essential feature of this concept—one can only view landscape from a historico-genetic, i.e. landscape-historical or artistic-architectural perspective (Pott 1998, 1999).

Not everyone is aware of how strongly landscape is influenced by culture. To emphasize this cultural imprinting, one speaks of cultivated landscape. One then perceives an opposition between natural landscape and cultivated landscape. Cultivated landscape is understood as an area that is informed by human agency, while natural landscape is meant to be untouched, a wilderness. But not every wilderness perceived as such is really that. The notion that a landscape is a wilderness is frequently only an interpretation. Many a landscape which is understood as a wilderness is informed by culture, too (Küster 1995, 1998, 2010).

Landscape is always created in the mind—as a cultural achievement of humankind. This is what the European Landscape Convention refers to: landscape is an area as perceived by human beings, its character resulting from the impact or interplay of natural or human factors. If one speaks of landscape, the human being is given centre stage, namely as a perceiver and designer. What a human being sees, he or she could capture on canvas—like a landscape painter.

Various conditions of the landscape are known to us from descriptions of lands and forests, but also from prints and paintings of former times. These sources essentially convey the same objective images, differing only in their approach and appraisal. The destruction of forests is hence occasionally cast in a negative and gloomy light under economic aspects where a light-filled, Arcadian landscape is perceived from an aesthetic perspective (Burrichter et al. 1980). The subjective viewpoint of the individual onlooker provides the starting point in any case.

The works of landscape painters therefore do not depict fanciful, but real landscape types of their time with individual, artistic means of expression. These landscape types were already being portrayed in the seventeenth century, for example by the Italian painter S. Rosa or, so outstandingly, by Cl. Lorrain from the Lorraine, with grazing cattle as accessories. Many pasture landscape motifs are also found in seventeenth century Dutch landscape painting, thought to have been

established by Jacob van Ruysdael. Inspired by van Ruysdael's landscape paintings, the English painter Thomas Gainsborough then depicted the pasture-informed "park landscapes" of his native country in the eighteenth century. They can either serve as an impressive backdrop for his sceneries, or be in the foreground as the presented subject, as is the case in his early landscapes, "Cornard Wood" (1748). This picture, which not only reflects the former condition of many forests, but also the various ways in which they were used, is of a historical expressiveness that verbal descriptions would be hard to equal. The pasture landscapes of the nineteenth century meanwhile arise before us with their remodelled and gnarled tree shapes from the pictures by the Romantics, M. von Schwind, L. Richter, Ch. Kröner, and others. That these Romantic painters should find enough inspiration in the diversity and expressiveness of common grazing lands at a time when Germany experienced the equivalent of the enclosure movement is virtually guaranteed (Figs. 4.1 and 4.2).

These few examples from three centuries in the history of western and central European art may serve to demonstrate how the expressive scenery of pasture landscapes has always cast a spell on the painters and printmakers of former times, and how widespread these landscape types were. The meaning of these

Fig. 4.1 Black-and-white reproduction of the colour painting "Cornard Wood" by Thomas Gainsborough (London 1748). The painting shows a typical thinning stage of wood pastures (from Burrichter et al. 1980)

Fig. 4.2 Similar thinning stage as in Fig. 4.1 in the "Borkener Paradies" wood pasture area with flowering blackthorn (*Prunus spinosa*) in the Ems River valley near Meppen in northern Germany (from Burrichter et al. 1980)

artworks hence extends beyond their purely artistic value as they simultaneously also document the history of the landscape and vegetation (Pott and Burrichter 1983; Ellenberg 1990, 1996; Ellenberg and Leuschner 2010).

Irrespective of how such pasture landscapes have inspired people of former times to artistic forms of expression, they also leave long-lasting impressions in modern man. This is because they are the epitome of an atmospheric landscape which, with its physiognomic diversity and small-scale interchange of pasture grass with colourful flowers, blooming forest edges, shrubby residual forest and bizarre tree shapes, has an incomparably stronger influence on pastoral life than the more or less pronounced monotony of our modern agrarian landscape. This diversity of the landscape, the apparently random, but in detail ever so regular, arrangement of vegetation units, the open land framed by trees and shrubs like scenery, jutting out and half covering the vista, lending it an appearance of vastness exactly because of this, all of it cloaks this landscape of contrasts in the magic of the primeval, and is yet anything but (Figs. 4.3 and 4.4). Its unique attractiveness results from the interplay of natural forces and anthropo-zoogenic influence (Pott and Hüppe 1991, 2008).

The idyll of these semi-natural pasture landscapes also inspired landscape gardeners to synthesize them. The product of their designs are the "English

Fig. 4.3 The rustic wood pasture area "Brögbern," north-west of Lingen in the Emsland region, provides a varied scene with a great diversity of structures, biotopes and species. It shows wooded cohesive parcels of beech-and-oak pasture forest, extensive cover of bushes and matgrass cattle tracks (from Pott and Hüppe 2008)

parks" and "English gardens", so highly popular to this day. In keeping with the model of the pasture landscape, an impression of randomness and apparent nature is to be created here, despite the clearly conceived planning and systematic arrangement of individual elements. A zoogenic pasture product hence becomes the subject of aesthetic purposes.

The Swedish botanist G. Romell and Germanist Jost Trier from Münster not only considered pasture landscapes as prototypical of the English parks, but also placed both in a direct historico-genetic context. While Romell (1967) regards the exclusively grazed pasture landscape as the starting product, Trier (1963, 1968) speaks of "terrains that were grazed and whose leaves were used", i.e. of combined grazing and pollarding landscapes from which the parks in England originally sprang. This means that such pasture forests and common pasturages are not only of interest for natural scientists as traditionally used relict landscapes, but also for art historians and garden designers as instructive and living study objects. Many of the landscape and forest parcels in the landed property of Italian Villas still show the traces of such intensive forest use today. Nowadays, they exhort us to interpret correctly in order to preserve such historic phenomena of forest use and forest treatment (Pott 2003).

Fig. 4.4 Woodland that has been thinned by grazing cattle, with grass pastures, clumps of bushes and residual forest as a "park landscape" in the "Borkener Paradies" region of the Ems River valley near Meppen in the year 1980 (from Pott and Hüppe 2008)

4.3 Nature or Culture?

The conscious perception of a cultivated landscape is fascinating. One should first of all analyse its components confronting us as either natural or cultural elements. But this is not the aim of capturing cultivated landscape: instead, all the details must be combined into an overall picture. This approach permits us to work out what constitutes the particular individual identity of a landscape.

Anyone wishing to understand the overall appearance of a landscape today will need to look into its history (Behre 1988, 2008; Pott 2014). Every cultivated landscape has been shaped over a very long time. It not only contains the traces of today's uses, but also those of various past uses. One could compare landscape with an archive that has been filled with documents of nature and culture for millennia. Knowing a specific landscape's history will help us arrive at better estimations of its future developments. Finding out about the consequences of earlier climate fluctuations, for example, will enable us to better predict the repercussions of current climate changes. The traditional uses of meadows and pastures, hedges, of pollarded willows and coppices generally supported the proliferation of rare animal and plant species (Pott 1996). If we wish to go on providing a habitat for such elements in our environment, the corresponding traditional uses

will also need to be continued. But adherence to earlier utilization methods can also be important for other reasons: in the past, people used to source raw materials locally, for example by using wood for heating and construction (Hoskins 1988; Bork et al. 1998), by extensive use of the land for pasture and pollarding, by a corresponding agrarian economy of farming and heath management (Hüppe 1993), and by a varied forestry industry with regulated systems of use, including the regular clearing of coppices and meadows by fire to grow rye (Pott 1985, 1986).

Uncovering the history of a landscape will often reveal that not everything one regards as such is actually nature. Scenically attractive heathlands such as the Lüneburg Heath are frequently equated with nature, but have been brought about by intensive use: the forests that used to grow there were cleared and the open land grazed by domestic animals. In many places, the heathland farmers even used to remove the humus layer to obtain fertilizer for their meagre fields. This was hard work and in no way as "romantic" as poets and painters pictured it (Emanuelsson et al. 1985; Küster and Volz 2005; Krzywinski et al. 2009). In time, overexploitation of the land had dramatic consequences: once the sand had been bared of the humus, the wind would blow it into dunes that buried entire settlements (Figs. 4.5 and 4.6). And wherever hardly any humus remaned, only heather would be able to grow. It burgeoned into a splendour that everyone felt compelled to deem beautiful.

Fig. 4.5 *Juniperus communis* heath in the "Bockholter Berge" nature preserve near Münster in Westphalia in a complex with dwarfshrub heathland of *Calluna vulgaris* on acidic, sandy soils. These formations arise from acidophilous mixed oak forests after fires and grazing by sheep, goats or German heath

Fig. 4.6 Sand dunes and various succession stages of their first and re-colonization by *Corynephorus canescens*-meadows of Corynephoretea-vegetation

People wished to protect this "nature" they took pleasure in and loved to hike through. Such a "nature" could not be conserved by simply leaving it to itself, however, because humus would accumulate again over time, and the heather overgrown by forest pioneers and shrub species. In this manner, heathlands could turn into forests, and that by very natural means.

The landscapes that people created with their often notable diversity of species and habitats can hence also only be preserved by people. Their use must be continued, or as an alternative heathlands, for example, can be maintained by removing shrubs at regular intervals. This is no longer profitable in agricultural terms. Any maintenance modelled on the methods of an earlier heathland peasantry will cost a lot of money and human effort. So how much are today's cultural assets of wood pastures or heathlands worth to us, or any other landscape for that matter?

4.4 The Development of Today's Forests Since the Last Ice Age

Looking at the countless pollen diagrams available by now for the end of the Late Glacial and the post-glacial period in central Europe, the regional differences are considerable, and often marked by considerable local deviations from the essential features of the vegetation's and landscape's general development. These are

attributable to human agency, whose influence characterized the post-glacial period, but not in the same manner everywhere. The anthropo-zoogenic impact on the progression of the vegetation and landscape was stronger than usually assumed so far (Pott 1985, 1986, 2000). But the basic outlines of the late- and post-glacial forest development are well-established by now and shall only be summarize briefly here for this reason:

In the late glacial Dryas period from around 11,500 BC, summer temperatures should certainly have reached or exceeded the 20 °C assimilation temperature conducive to plant growth, at least near the ground, long before the pine (*Pinus sylvestris*) gained a foothold. The predominant vegetation types were mats rich in grasses and sedges, coppices of low-growing willows, dwarf birches and sea buckthorn (*Hippophae rhamnoides*), as well as *Artemisia*-rich plant communities of the subarctic steppe type. The early appearance of *Ephedra* pollen (Burrichter and Pott 1987), amongst others, speaks for a continuous character of the climate in this period. One is compelled to date a possible migration of continental steppe elements to central Europe to this time. This is supported by the observation that insular *Stipa* and *Festuca* steppes are also interspersed in the southern margins of the Arctic tundra today and able to exist there.

The "birch-and-pine" period (Allerød) and later Preboreal around 9000–8000 BC brought extensive coverage of ice-free central Europe, with birch forests in the north-west and pine forests in the east and south-east. The vegetation was evidently comparable to subarctic forest steppes in character, but the existence of extensive open steppes is to be expected in drier areas like the Thuringian and Mainz basins, which probably already had less rainfall then. The blocks, gravel and shifting sand areas created by the periglacial climate will meanwhile have also provided many habitats where steppe plants enjoyed an advantage over forest growth. Neither should the open character of the pineland be underestimated: there is no reason to assume that the pine forestation of the lowlands equalled the destruction of subarctic steppe elements or impeded the transit of Pontic-Sarmatic plants from the Balkans and Danube region in the Allerød or Preboreal. Especially as the association of true steppe plants with light pine forest into a forest steppe is still as characteristic of the continental areas with cold winters as a vegetation type today as the forest-free steppe itself. A great many steppe plants from south-eastern Europe—resilient to the cold and equipped with devices for enduring great dryness and sudden temperature fluctuations—should have already migrated into large parts of Central Europe by the Allerød (Fig. 4.7).

A further consolidation of the forests is to be assumed in the "hazel period" (early warm period, Boreal around 7000–6000 BC), where a strong proliferation of Hazel (*Corylus avellana*) went hand in hand with an advance of pine trees into the previously birch-rich landscapes, while at the same time the replacement of the pines by mixed oak forests (including elms) was also starting in rich soils.

Especially in the western uplands with their ocean-influenced, humid climates, the pine and birch trees were supplanted by hazel bushes spreading north of the Alps from the west.

Fig. 4.7 The Scots pine (*Pinus sylvestris*) has a broad physiological and ecological amplitude and is nowadays usually found in extreme habitats, by dint of competition, as on the sand dunes here. It is a relict species in central Europe which, coming from the south and east, already covered the whole of Europe in the Preboreal period, before the climatically favoured broad-leaved tree species forced it into today's moorland and dry habitats, where the deciduous trees couldn't follow

Entire hazel forests must have existed for a time, especially in the Harz region, the Weser Uplands, the Eifel, the Rhenisch Slate Mountains, in Upper Hesse and the Black Forest (Fig. 4.8). Hazel bushes were also found in the lowlands, but probably not quite in such numbers. This situation, also applies to the east, where they were only able to flourish once the local climate had also become more Atlantic, after the English Channel had broken through. The Boreal proliferation of the hazel was meanwhile also unable to make as much headway in the south-eastern parts of central Europe because some of its potential growing areas were already occupied by the spruce (*Picea abies*). Coming from its refuges in the northern Dinarites (mostly Slovenia and Croatia) and south-eastern parts of the Alps, the spruce tree had spread around the high mountain ranges in the east and also become indigenous again in the regions to the west from there. The spruce trees thrived in the pine forests of the time, shading out the Scots pines (*Pinus sylvestris*). In this manner they spread across the eastern Alps from the south-east right through to Upper Bavaria, the Bohemian Forest, the Ore Mountains and Thuringian Forest, up to a number of upland areas in the Rhön Mountains, the Sauerland region and through to the Harz Mountains. The progressive distribution of hazel bushes from the west and advance of the spruce from the south-east laid the foundation for

Fig. 4.8 The hazel (*Corylus avellana*) needs warm temperatures and loves light. The bushes are suitable for coppicing and still cultivated in copses today. This is what central Europe's first deciduous forest formations must have looked like in the Boreal period

divergent developments of the vegetation and landscape in the west and east of Germany and central Europe that is still characteristic today.

The Atlantic period, which followed from around 6000 to 3200 BC, lasting approximately 3000 years, was attended by the appearance of a stable forest landscape largely characterized by elm (*Ulmus* spec.), oak (*Quercus*), lime (*Tilia*

Fig. 4.9 Xerothermic vegetation complex with dry grasslands on shallow rock and a natural drought tolerance limit of the forest at the "Klusenstein" cliff in the Sauerland region. The forest has been spreading everywhere since the Atlantic period and only rocky habitats such as this one have remained naturally forest-free for edaphic reasons

spec.), ash (*Fraxinus excelsior*), maple (*Acer* spec.) and alder trees (*Alnus glutinosa*). Although most of these species had already started appearing towards the end of the Boreal, they only reached their full distribution in the Atlantic period. The most significant climatic change that the mixed oak forest period brought in comparison with the early warm period (Boreal) was increased humidity. The spreading of dense, mixed deciduous forests markedly reduced the areas of xerothermic vegetation, which increasingly lost out in the competition for habitats, and rendered the transition of thermophilic floral elements through greater distances largely impossible. The restriction of photophilic and thermophilic species to special, insularly dispersed, forest-free sites sundered their connection to the main distribution areas (Fig. 4.9). This created the relict-like areal disjunctions still observable today.

With the summer temperatures 1.5–2 °C higher than today, on average, and more rainfall, there can be no doubt that the proliferation of broad-leaved species was linked with the general increase in precipitation, which is also confirmed by the appearance of a great number of low and high moors, many of them extensive. Given the highly diverse habitat conditions in central Europe's individual natural regions, various variants of the Atlantic mixed oak forest need to be assumed, more or less all of which have also been substantiated by way of pollen analysis:

- alder-rich variants in the marshy lowlands of the large river valleys and flat country
- elm-rich variants on nutrient-rich, fresh soils (most of all in the riparian zones)
- lime-rich variants in the loess regions and above ground moraine, as well as with higher proportions of ash (*Fraxinus*) and maple (*Acer*) in the higher reaches of the low mountain ranges
- birch-rich variants on the poor sandy soils of the north-west German geest (e.g. with pine, *Pinus sylvestris*)
- possibly spruce-rich variants in the Alpine foothills and eastern uplands.

The significant climatic change brought by the period of mixed oak forests (Atlantic period) in comparison with the Preboreal and Boreal, i.e. a higher humidity, also continued in the warm period (Subboreal) to follow. One profound consequence was a supplanting of the pine in the western parts of central Europe by biodiverse deciduous forests including oak, elm, lime, and later increasingly also beech trees (*Fagus sylvatica*). The spreading of sub-oceanic shade-tolerant species, first and foremost beeches, and progressive appearance of high moors point to a damp and cold climate with a growing proportion of snow and shortened growing season. Starting from the Subboreal, at the latest, the open landscapes with their communities of steppe plants can also be assumed to have been pushed out of the plain into small, insularly dispersed, exposed patch habitats in the arid regions, ensuring the final severance of connections to their areas of origin. The flora and vegetation were provided with their autonomous character since then.

The various hardwood and softwood species have hence migrated in our direction again from their refuge areas in the course of later climate improvements during the late ice age and thereafter. They came in stages and a very specific order, controlled by climate changes, over a period of approximately 9000 years from the first to the last migrating species. In the process, the beech tree (*Fagus sylvatica*) spread northwards from its ice-age refuges in the Mediterranean until it reached present limits, initially probably taking at least two routes to northern and central Europe from the south-west and south-east (Fig. 4.10).

The post-glacial proliferation of the beech tree in central Europe proceeded under simultaneous human influence almost everywhere, however. This means that there were constant overlaps between the natural course of the development and the moulding influence of people (Speier 2006). The selection of places for human settlement in prehistoric times was almost exclusively restricted to locations that could support beeches. It has long been known that the first notable interventions of human beings in the virtually continuous cover of deciduous forest after the Atlantic period took place at the beginning of the Neolithic Age, when the switch from the Mesolithic Age's land use to a more or less sedentary lifestyle and economy set in. Ever since then, the influence of farmers and cattle breeders on the remodelling and refashioning of the vegetation and landscape, needs to be recognized as decisive.

Fig. 4.10 Young beeches (*Fagus sylvatica*) are establishing themselves in a mixed oak forest in northern Germany after a lowering of the ground water table. This is how the spreading of the beech tree must have proceeded in the Atlantic period: after the climate change in the Subatlantic period, the shade-tolerant species is gradually overgrowing the light-dependent oaks and will henceforth dominate the tree layer (Pott 2010)

4.5 Man and Nature

Sedentary farming spread throughout central Europe as a new lifestyle in the sixth millenium BC. The so-called "neolithic revolution" had advanced there from the Balkans and Danube region in the south-east along with the people of the Linear Pottery culture. The economic and social switch to a sedentary rural lifestyle with agriculture and animal husbandry was simultaneously also attended by a transformation of the natural landscape into a cultivated landscape. The settlement areas of the older Linear Pottery culture in loess-rich plains show the first impact of farmers on the primeval landscape of the time. Based on the evidence from pollen studies for grain cultivation, the establishment of the first permanent settlements can be dated to around 5500–4500 BC. The post-glacial warm period, which led to better climate conditions in central Europe than we experience today, was evidently conducive to this process. The earliest farming cultures hence created the first open landscapes for their respective cultivation and use (Fig. 4.11). The settlements of succeeding Rössen groups (from around 4000 BC) or other Middle/Late Neolithic cultures became established in approximately the same time periods as the

Fig. 4.11 Reconstruction of a Neolithic Linear Pottery longhouse of the Rössen Culture in the Oerlinghausen open-air museum near Bielefeld. These thatched oak constructions could reach a length of 40 m and accommodated clans and their domestic animals. These buildings were not infinitely long-lived and devoured a tremendous amount of wood in the heretofore primeval landscape's first cleared islands

Linear Pottery culture, but extended from the primary settlement areas to the adjoining peripheral zones of limestone hills and highland slopes. They find their chronological and spatial pendant in the passage graves of Nordic Megalith architecture that have come down to us as impressive relicts of the so-called Funnelbeaker people and pay witness to the first settlements in north-western Europe's geest plains. Around 3000 BC, the largely dry and somewhat richer geest soils of the beech-and-oak-forest (Fago-Quercetum) constituted the nucleus of agricultural settlements and served the creation of farms and arable land. Many surviving Megalith graves of the Funnelbeaker cultures are striking testimonies to these first settlement periods. The northward advance of Neolithic farming cultures across the loess boundary did not take place until around 4000 BC, but very soon almost all the other areas of northern Europe had been "neolithicized". The Funnelbeaker culture was the carrier of this neolithicization in large parts of central and northern Europe. This and other Neolithic or later cultures can often be clearly observed in the pollen diagrams. They represent the beginning of human influence on natural ecosystems, and of the two-way interaction between humankind and nature! This evidently involved two different approaches, both of them described for the first time in Denmark: one with an emphasis on pollarding and with relatively little intervention in the forest, and then the so-called land seizure, where forest grazing resulted in a considerable thinning of the forest. *Fagus sylvatica*, for example, has never been able to claim its potential territory in the Pleistocene

lowlands of north-western Germany for this reason. We can assume that the potential proportion of beech was higher on these Pleistocene Old and Young Drifts, and that the natural beech-and-oak forest (Fago-Quercetum) would have potentially claimed a greater area than today's oak-and-birch forest (Betulo-Quercetum) in the absence of human settlement activities. Even the prehistoric influence of human beings was therefore not exerted on a static vegetation but on a dynamic process; and one can no longer speak of a continuously natural vegetation since the later Atlantic period. Some authors consider this human impact on the natural landscape to be so drastic that a new term has been coined for the succeeding age of today, dominated as it is by humankind and human activity: the Anthropocene (Steffen et al. 2007).

Except in soils that were poor in nutrients or affected by ground or back water, the beech tree achieved absolute dominance almost everywhere at the time on various substrates (Fig. 4.12). Due to its edaphic and climatic advantages, it also developed its tremendous competitive power across small-scale locational differences, which still permits a rough tripartition into beech, mixed beech and beech-free forest today. The locational amplitude of the beech is so great that it forms a continuous area under current climatic conditions, from the plain to the montane level, where its main region lies, and from Sicily through to southern Sweden—except for habitats that are dry in summer. As an Atlantic-Submediterranean geoelement, *Fagus sylvatica* is even able to form the forest border in mountain ranges that are influenced by Atlantic climate, such as the Cévennes and Vosges, and in the Swiss Jura. The so-called maritime timber line lies where a median temperature of around 10 °C is still reached in July.

Today, *Fagus sylvatica* is found at nearly all altitudes of the low mountain ranges, from the flatlands to the highest slopes. The beech forests meanwhile are most common in the plain in the northern environs of the low mountain ranges, on limestone and loess. They are already typically developed at altitudes of 50 m above sea level, while the woodrush-beech forests (Luzulo-Fagetum) on silicate rocks do not reach altitudes lower than 160 m above sea level, and furthermore often still need to be regarded as transitional types between beech-and-oak forests and pure beech forests at these altitudes (Fig. 4.13). This phenomenon clearly demonstrates the superior competitive power of the beech at better locations. In the geest areas of the northern German plain, for example, the beech is only found in association with the sessile and common oak (*Quercus robur* and *Q. petraea*), most of all in the *Lonicera periclymenum*-beech forest (*Periclymeno-Fagetum)*, but also in the oak-hornbeam forests of the *Stellario-Carpinetum* type (phytosociological terms as per Pott 1995). In north-western Germany, the loess loam soils and loess-containing substrates of the fertile plains are local domains for continuous lowland beech woods from the millet grass-beech (Milio-Fagetum) forest complex. This small-scale differentiation reaches back to the time of the beech invasion.

The great range expansion of the woody plants as described above started in the course of the post-glacial climate changes and development of the vegetation. The extermination of so-called megaherbivores, i.e. the largest grazing animals, since the land had been seized by human beings in the stone age, has meanwhile certainly

Fig. 4.12 A beech (*Fagus sylvatica*) forest with closed canopy and little understory, referred to as "hall forest" in Germany because trees of all ages make their way into the canopy, creating the impression of a Gothic cathedral in old-growth forests

been conducive to the development of forest thickets (Martin 1967; Vera 1997; Vera et al. 2006; Johnson 2009). People not only exterminated these large animals by hunting them, however, but also by claiming ever more land.

The megaherbivore theory is based on the assumption that large herbivores will have a crucial impact on the vegetation and landscape wherever they are found in

Fig. 4.13 Limestone-and-beech forest of the Galio odorati-Fagetum type (after Pott 1995), rich in spring geophytes like the hollowroot-birthwort (*Corydalis cava*)

great numbers. They are in particular able to break up previously continuous forests sufficiently for them to be supplanted by semi-open, park-like pasture landscapes. This is for example demonstrated by the African tree-savannahs, kept forest-free by elephants as a keystone species. The theory attributes the fact that central Europe, for example, was not a savannah-type park landscape in prehistoric times, but a continuous forest area, to people keeping the animal populations small by hunting, and/or to the extinction of the largest megaherbivores such as elephants and rhinos in central Europe by the end of the last ice age (Martin and Klein 1984).

In the Atlantic period, when people began to settle down, central Europe was dominated by extensive forests of oak, elm, lime, ash and maple trees, as we have seen, with beeches and hornbeams added later. The clearing activities and forest grazing opened the forests up over time, creating regionally differentiated, open and semi-open cultivated landscapes with small-scale structures of fields, pastures and meadows, along with a great number of forests, copses and hedgerows. Areas of open land are therefore anthropo-zoogenic in the forest climate of central Europe.

Our observations concerning the impact of grazing livestock on what used to be more or less continuous forests date from the time of Early Medieval forest use, which led to various remodellings of the landscape, and hence forest structures, depending on the type of grazing livestock and grazing intensity (Pott and Hüppe 1991, 2008).

The megaherbivore theory deems it likely and possible, however, that a mosaic of areas with various degrees of openness and various succession stages would also predominate in large parts of central Europe through the browsing of animals alone, without human influence. If this were to be the case, one would need to assume the continued existence of large herds of wild animals such as wild horses, bison and other herbivore species (Johnson 2009).

What speaks against the herbivore theory is the existence of species that depend on an undisturbed development of the forest over centuries. In addition, central Europe has hardly any endemic open land plant species and subspecies, in contrast to the Mediterranean or steppe landscapes in the east, which would indicate a relatively young age of the open vegetation, even if there are also contrary opinions to this (Walentowski and Zehm 2010). Pollen research has also failed to turn up any indications of open landscapes for the period in question (Birks 2005; Litt 2000). The pollen of open land species (such as grasses, for example) only start appearing more frequently with appreciable clarity from the beginning of the Neolithic Age and the introduction of agriculture and cattle breeding. If open landscapes had indeed been widespread before that, this would be demonstrable without fail.

Ever since the Neolithic period, the domesticating livestock species had furthermore started to compete for food with the aurochs, wisents and wild horses, which sought refuge in the riparian areas of the many-branched rivers, in swamps and moors. Switching to the forage plants of the forest was impossible for most wild animals because they are unable to digest and/or neutralize the substances and antigens contained in many herbs and woody plants. This was different for deer and elks (*Alces alces*), which feed on highly nutritious buds and shoots, and found plenty of grazing in the new growth of the forests. The elk, which loves forests with many shallow waters, has been slowly forced out into eastern Europe, however. Red deer (*Cervus elaphus)* and wild boar coped well with the loss of open pasture landscapes and became true forest animals. Some of the exterminated grazing animals are being reintroduced today and employed to maintain grassland landscapes and common pasturages for nature conservation. Especially the abandoned former wood pastures that are popularly referred to as “Urwald” (primeval forest—e.g. Bentheimer Urwald and Neuenburger Urwald, and the Hasbruch north of Oldenburg, Figs. 4.14 and 4.15) in Germany and have been left to themselves as protection areas and/or so-called “natural forest reserves” for quite a while, are showing a development today where shade-tolerant trees are growing up densely until they tower over the old, broad-crowned pasture trees and shade them out (Pott and Hüppe 1991, 2008; Behre 2010). The euphemistic term “natural forest reserve” is not quite accurate here because these are not natural forests, but the old forests should of course be allowed to continue developing naturally. Perhaps “forest reserves” would be more honest, with more or less dense, continuous timber forests being the natural successor.

Fig. 4.14 The "Hasbruch" near Oldenburg is a former wood pasture and pollarding forest whose multi-layered structure is still recognizable today: oaks were left free-standing to supply timber and acorns for the animals, while hornbeams were moulded into candelabra-type shapes by regular pollarding to provide leaf fodder. The evergreen *Ilex aquifolium* directly on the forest floor is the result of positive grazing selection (from Pott and Hüppe 2008)

4.6 Forest Landscapes or Park Landscapes?

The duration, intensity and impact of the anthropogenic influence in the Neolithic period were not consistent in the various natural regions of central Europe, however, but exhibited temporal and regional differences between the coastal regions, geest areas, mountains and uplands with their carbonaceous and loess soils, as well as the low and high mountain regions.

Geobotanical research into the intensity and continuity of settlements, into the evidence for the migration or cultivation of specific crops plants, and into the manner of these agricultural activities, was only started around 50 years ago. It is founded on the decisive methodological basis provided by the knowledge of, ability to register, and statistical confirmation of pollen from plants whose presence is largely or exclusively linked to forms of human settlement. Typical settlement indicator pollen for north-western Germany for example include those of grain species (cereals), plantain (*Plantago*), goosefoot (*Chenopodium*), mugwort (*Artemisia*), red sorrel (*Rumex acetosella*), stinging nettle (*Urtica*), cornflower (*Centaurea cyanus*), buckwheat (*Fagopyrum*), flax (*Linum usitatissimum*) and walnut

Fig. 4.15 Old oaks formerly subjected to copse management and coppicing grew through again once this was discontinued, creating the impression of an eerie "fairy tale forest" today, with the trees grown into bizarre shapes. "Ahlhorner Heide" heath in the "Wildeshausener Geest" nature park, north-western Germany (from Pott and Hüppe 2008)

(*Juglans*), as well as grasses, composites, etc. All these plants were part and parcel of the original native vegetation, but have been advanced by human beings. The evaluation of prehistoric cultivation methods additionally relies on indicators of a secondary nature that mostly point to a partial clearance of the landscape such as, for example, the decline of specific tree species and proliferation of grass and herb pollen. These indicators, among others, permit us to reconstruct the proportion of forested to open land.

The coastal marsh already featured high, verifiable frequencies of grass pollen in the Atlantic period, which originate from naturally wood-free tidal reeds or salt meadows and reflect the transgression and regression phases of the North Sea in their oscillating graphs. Permanently forest-free landscapes only start appearing recently along with human settlement.

Similar, naturally high grass pollen frequencies that occur before the appearance of settlement-indicating pollen are also found in the upland moors. These moors were originally sparsely wooded and covered with tall *Molinia* tussocks, as is still observable occasionally today.

The Atlantic period witnessed the development of deciduous forests with beech trees everywhere, which is reflected in a high frequency of tree pollen. Only the settlement activities of the Bronze Age and their expansion in the Iron Age served

to reduce the forests and provide the first anthropo-zoogenic open landscapes. Land seizure is also evident in the Alpine foothills, where agriculture only plays a minor role today because of the specific climate situation, and livestock farming now predominates with its pasturages. But large parts of these foothills were put to agricultural uses right into the eighteenth century. This used to involve special regional forms of agriculture (e.g. ridge and furrow) where the areas in question needed to be wrested from the forest. But the landscape only opened up in very recent times here as well. Even the highest ranges of the Alps attest to oscillations of the timber line with a highly fluctuating share of tree pollen since the natural climatic change from the Boreal to the Atlantic period, with anthropo-zoogenically induced timber line depressions at the end of the Neolithic period and in the Bronze Age. The continually verifiable grass pollen frequencies largely stem from the alpine level, where we have been able to produce paleoecological evidence for a shifting of the timber line to over 2350 m above sea level in the warm period from fossilized Swiss pine wood dating from 6860 to 6140 years BP (Fig. 4.16). The pollen analysis data hence provide no indications for natural park landscapes in mostly forested, temperate central Europe throughout the entire geographic comparison (Pott et al. 1995).

Fig. 4.16 Larch and Swiss stone pine forest of the *Larici-Pinetum cembrae* type (after Pott 1995) that has been thinned out by alpine grazing and wood harvesting at the intra-alpine timber line in the Fimbatal valley (Val Fenga, Silvretta, Switzerland). Post-glacial, natural and climate-controlled fluctuations of the timber line by several hundred meters have been substantiated in this region for the warm phase of the Atlantic period around 5000 BC (from Pott et al. 1995)

This supports the assumption that large swathes of central Europe have been deforested between the Neolithic age and today. This still leaves partly unclear the proportion of natural open land in wet and humid habitats, e.g. upland and lowland moor landscapes, and in the riparian zones. As well, the exact share of natural dry grassland biotopes in the open land areas will be debated again and again. But what is certain is that the natural continental and Submediterranean dry grassland communities in the climatically controlled forest and grass steppes of eastern and south-eastern Europe are increasingly turning into natural open landscapes. This should always be taken into account for the discussion.

In the deciduous, nemoral broadleaf forest zones within the potential distribution area of the beech, primary xerothermic dry grasslands are limited to small-scale extreme habitats only. However, extensive secondary dry grasslands have often spread to open land areas through mowing and grazing in the course of the anthropo-zoogenic thinning of the forest. Left untouched, these areas will all gradually be reclaimed by the forest.

Even the prehistoric deforestation stages in central Europe of the Neolithic and Bronze Age are very beautifully demonstrable by combinations of modern pollen analysis and archaeobotanical data. These stages continue on into the Iron Age and into the era of the Roman Empire, with local reforestation of briefly neglected, formerly cultivated areas, not being observable before the Migration Period.

Many studies demonstrate widespread agricultural activity with open land at the end of the pre-Roman, Iron Age extending far beyond the Roman Empire's contemporary boundaries. Around 450 AD, however, at the high point of the migrations, there are increasingly unequivocal indications of reforestation processes that are linked to declining settlements and a correspondingly reduced agricultural activity. Only at the beginning of the Early and High Middle Ages around the turn of the millennium are the anthropo-zoogenic open land areas inexorably on the increase again, at the expense of the forest.

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