ABSTRACT

Jason S. Rogers. LOGBOATS OF THE MORAVIAN GATE: MONOXYL DUGOUT VESSELS FROM CENTRAL EUROPE. (Under the direction of Dr. Lawrence E. Babits) Department of History, May 2004.

This thesis describes and analyzes all known dugout logboats from the region of Moravia, the eastern third of the Czech Republic. This region essentially corresponds with the drainage basin of the Morava River. There are 13 vessels in the study, of which 8 are still in existence. As all previously published information has been descriptive in nature; no analysis has ever been carried out. This investigation, therefore, fills two gaps: it disseminates data on the Moravian vessels to the English-speaking world, and it subjects them to analysis.

The analysis consists of descriptions of the natural and human contexts of the vessels, that is, the region's physical geography and the human history, as well as a quantitative analysis of six vessels, where enough data exist to perform the analysis. The thesis also contains chapters on constructing dugout logboats, a catalogue of the Moravian vessels, and a review of established analytical methodologies.

The analysis of Moravian logboats shows the tremendous load-carrying capacities of these vessels. The physical and historical contexts, combined with the results of quantitative analysis, clearly suggest that these vessels were intended to carry heavy and bulky cargoes. As such, they were indispensable for the economic prosperity and well-being of the communities that constructed and used them.

LOGBOATS OF THE MORAVIAN GATE:

MONOXYL DUGOUT VESSELS FROM CENTRAL EUROPE

A Thesis

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Any inaccuracies, mistakes, or errors that remain in this thesis are, of course, solely the author's responsibility.

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CHAPTER 1: INTRODUCTION AND RESEARCH QUESTIONS

Dugout logboats (called *monoxyls* in many European languages, from Greek "mono" (single) and "xylum" (trunk)) are one of the most ancient types of watercraft. Logboats are found on every inhabited continent, and Basil Greenhill suggested that a majority of boat types the world over has logboats as their remotest ancestor. Development of other ancient watercraft roots – rafts, skin boats, and bark boats – is inherently limited by the raw material and the nature of the structure (Greenhill and Morrison 1995:101). Dugout vessels too are limited by the raw material. They can, however, be expanded and enlarged with additions such as washstrakes and spray deflectors. Many scholars suggest that this led to the development of planked vessels (for example, Johnstone 1980, McKee 1983, and Greenhill and Morrison 1995).

Logboats are nevertheless perceived as somewhat esoteric and obscure, even in the field of nautical and underwater archaeology. Scientific investigations of ancient watercraft tend to focus on plank boats, while logboats are often considered "distasteful" (Fry 2000:1), or even "unloved" (McGrail 1978:22). It is often impossible to date them without using expensive laboratory methods (C-14 or dendrochronology), early literature on logboats tends to be of the "Pfalbauromantik" type; later works are often extremely technical in nature (for example, McGrail 1978). The study of logboats should not be neglected, however, as much can be learned from these vessels about early navigation, cargo, trade and transport, as well as the development of watercraft construction, technology and usage.

Chronologically, logboats span a huge range – from the Stone Age until modern times. The oldest dated European vessel, from Pesse in the Netherlands, dates from c.6315 BC (Johnstone 1980:46). Dugout vessels were still in use in parts of Poland, Slovakia, and the Alpine Lakes as late as the 1950s and 1960s. Logboats have never gone out of use in some regions, and are still commonly found in areas of Africa, South America, and Southeast Asia. Thus, logboats have been utilized over a longer span of time, in more parts of the world, than any other form of transport. Despite their widespread occurrence, only a few hundred recovered specimens are known worldwide. Most were not scientifically excavated or recorded; even fewer are published. Logboats appear deceptively simple, yet many subtleties in their construction and usage call for further investigation: for example, the purpose of the transverse ridges found in so many vessels, their intended cargo and usage, and the socio-economic significance to their builders.

The technology of boat building and watercraft is closely linked to a region's socio-economic history and resources. In his study of Polish dugout vessels, Waldemar Ossowski noted:

> Logboats are a particularly valuable group of artifacts, which can tell us a great deal about navigation in former times. The forms of logboats were dependent primarily on their purpose, conditions of operation, and the sophistication of the boat-building technology. On this basis we can make inferences about the extent to which the waterways were utilized (Ossowski 1999:221).

Dugout vessels in general are difficult to analyze because they lack reliable dating and archaeological context. Logboats of the British Isles are well represented in scientific literature over the last two decades, with comprehensive catalogues and individual case studies published for England and Wales (McGrail 1978, 1988; Marsden 1989), Scotland

(Mowat 1996), and Northern Ireland (Fry 2000). A few dedicated researchers from other regions have made valuable contributions (Cornaggia and Calegari 1978; Christiansen 1990; Arnold 1995; Okorokov 1995; Ossowski 1999), but there are still many blank areas to fill before creating a comprehensive study of European dugout vessels (Figure 1).

Figure 1. Map of Europe (University of Texas at Austin 2004)

One such gap, at least to the English-speaking world, is the Czech Republic (Figure 2). A few researchers have carried out investigations of logboat finds in Bohemia and Moravia, mainly in the 1950's and 1960's (Novotný 1951; Hrubý 1965b). The author knows of only one recent publication mentioning logboats, Lumír Poláček's summary of wooden artifacts from the Mikulčice excavations (Poláček 2000). No comprehensive catalogue of logboat discoveries, either in Bohemia or Moravia, exists. None of the existing data regarding Czech logboats have been published in English, although a sizeable body of literature on Mikulčice exists in German (for example Klanica 1985; Poláček 2000), as well as in Czech (Poulík 1975; Klanica 1986). Thus, there exists a need to consolidate these data, and make them available to the English-speaking world.

Figure 2. The Czech Republic (University of Texas at Austin 2004)

This study focuses on the dugout logboats of Moravia, the region comprising the eastern third of the Czech Republic. The sample size is small – there are 13 reported or documented finds, of which only eight are known to be extant. One vessel was extremely fragile and, after being recorded, was re-interred and remains *in situ* (Mikulčice IV). Three other logboats from Mikulčice are displayed in the site museum, two vessels are displayed in the Slovacké Museum in Staré Město (Spytihněv and Uherské Hradiště), and the most recent find (Mohelnice) is currently being conserved at the Natural History Museum in Olomouc. The final extant vessel (Příkazy-Hynkov) is in storage at a state depository in Olomouc. Despite the relatively small number of finds, the presentation of evidence is of course still relevant, and fills a gap, both linguistically and geographically, in the archaeological record.

This thesis will examine Moravian logboats, with goals of determining similarities and differences when compared with vessels across Europe, drawing conclusions regarding purpose and usage, and revealing spatial and chronological patterns. The study will summarize knowledge of all known Moravian logboats, and place them in the appropriate geographical, historical, and theoretical setting.

The intent of this thesis is to add to the body of scientific understanding and analysis of dugout logboat vessels, and to fill in a few of the gaps in our knowledge of past human societies. By examining a region's geography, archaeological record, documented history, and surviving watercraft, we can make inferences about the types of cargoes carried and the technological sophistication of the cultures in question. The dugout vessels recovered from the Morava river valley can tell us much about the extent of riverine navigation in Moravia, the peoples that inhabited this region, and their way of life.

This thesis makes the following theoretical assumption: Logboat purpose, functionality, and intended usage can be indicated by typological and morphological analysis of empirical evidence. The empirical evidence takes the form of quantitative measurements and calculations of attributes such as mass and dimension, as well as descriptions of morphological features such as bow and stern shape, division of internal space, and evidence for thwarts or other fittings. Moreover, logboat characteristics are indicative of other cultural and societal mechanisms and behavior (for example, allocation of resources and labor, level of political organization, etc.). Based on these assumptions, this thesis proposes the following questions:

1. What similarities and differences do Moravian logboats exhibit when compared with previously investigated vessels from other regions of Europe?
2. What conclusions can be drawn regarding logboat construction, intended purpose, and usage in Moravia?
3. Are there any evident patterns, either spatial or chronological, in Moravian vessels' features?

Following this introductory chapter, the second chapter will examine the Morava River valley's physical environment, including the geological processes involved in its formation, and the historic topography. The third chapter, while not intended to be a comprehensive history of the region, will describe the human context, from earliest prehistory to modern times. There is special focus on riverine resources and watercraft usage. Chapter Four outlines theoretical aspects of the study of logboats and summarizes major work done on the topic. The fifth chapter describes in some detail the main methodologies and systems used for analyzing dugout vessels' construction, performance, and capabilities. Chapter Six catalogues and describes all known Moravian logboats, including scale drawings. The vessels are analyzed in Chapter Seven; results of analysis are interpreted to draw conclusions about the vessels' intended purpose and usage. Conclusions are presented in Chapter Eight.

CHAPTER 2: THE PHYSICAL SETTING

Moravia's topography and geographic location are the keys to understanding transportation developments in the region. Moravian watercraft were specifically designed and built for circumstances specific to this physical and social environment. This chapter outlines the geographical and physical conditions that made the logboats' role so significant in the Moravian setting.

Just as Europe today is a patchwork of peoples, cultures, and languages, so the European continent is a varied landscape, full of "subregions and microclimatic zones…creating a bewildering variety of niches for its human communities to occupy" (Figure 3) (Cunliffe 1994b:1). Europe is bounded by water to the south, west, and north,

Figure 3. Topography of Europe (NASA 2004)

allowing access to the continental margins. Europe's mountains – including the Alps proper, the Carpathians, the Apennines, and the Balkan ranges – are generally oriented along an east-west axis, and thus channel interregional travel in these directions. Many European interior lowland basins and fertile valleys can only be reached through a very few well-defined corridors, i.e. the Burgundian Gate, the Moravian Gate, or the Iron Gates of the Danube (Milisauskas 2002:14). North-south travel in Central Europe is almost entirely blocked by the Alpine and Carpathian massifs (Figure 4). There is only one lowland pass over the ranges: the so-called Broad Moravian Gate, connecting the Morava River valley to the south with the Oder River system to the north (Figure 5). Moravia's geography and topography have endowed it with great significance, not only as a transportation and communication corridor between northern and southern Europe, but also as a rich and fertile agricultural zone.

Moravia comprises the eastern half of the modern Czech Republic, with an area of nearly 15,000 square km. Moravia is bordered on the north by the Jeseníky range of the Bohemian massif, to the west by the Bohemian highlands, and on the east by the westernmost extension of the Carpathian range. To the south, Moravia is open to Austria and Slovakia. The Morava river system flows south into the Danube and is the region's dominant geographical feature. The Morava is essentially the dividing line between two entirely different geological units: the Bohemian horst to the west, part of the larger Hercynian massif, and the West Carpathians to the east, geologically assigned to the Alpine province (also called the Alpine-Carpathian region) (Svoboda 1966:7; Pesl et al. 1967:5).

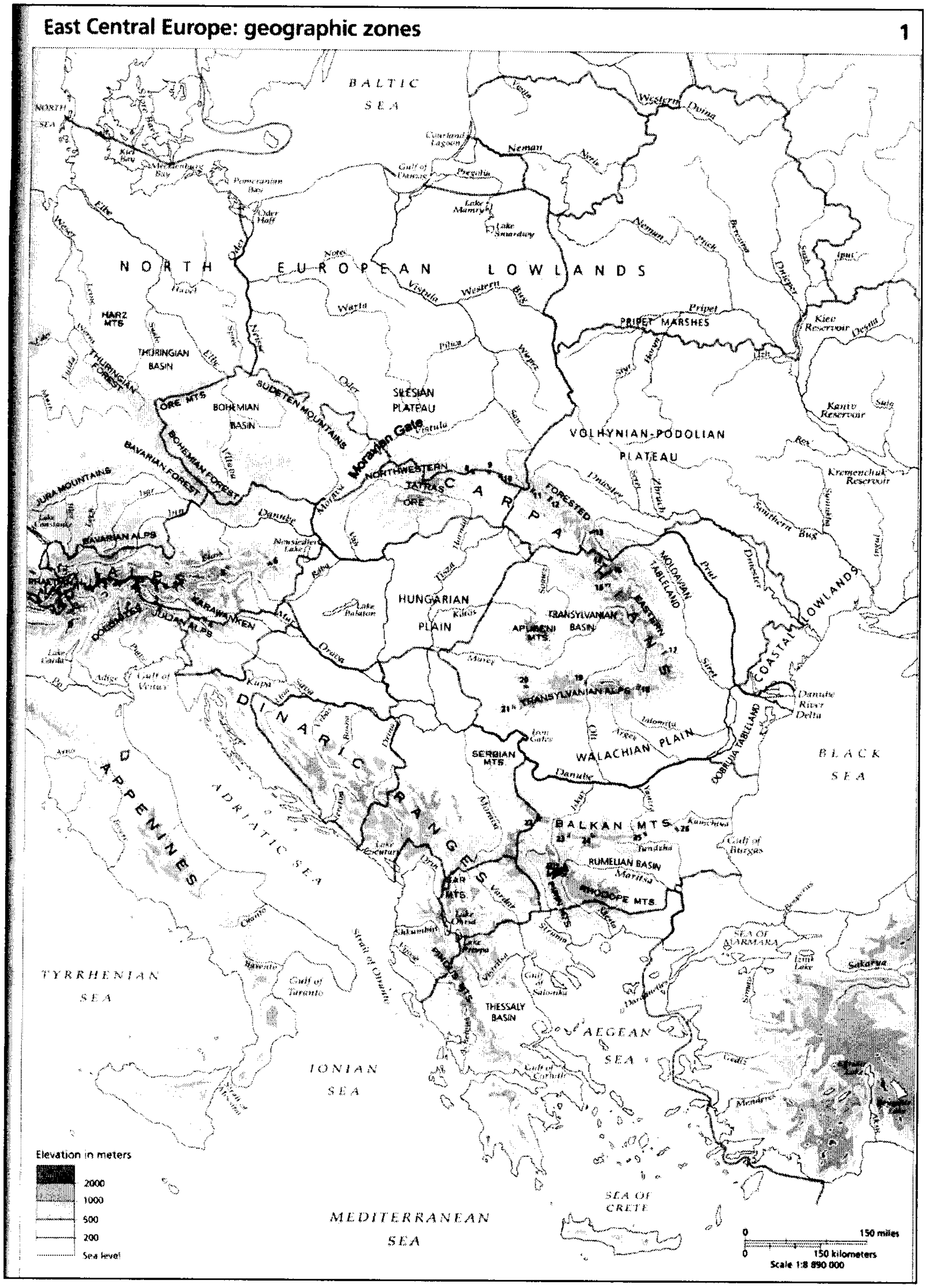


Figure 4. Alpine and Carpathian Mountain Ranges, Moravian Gate (Magocsi 1993:3)

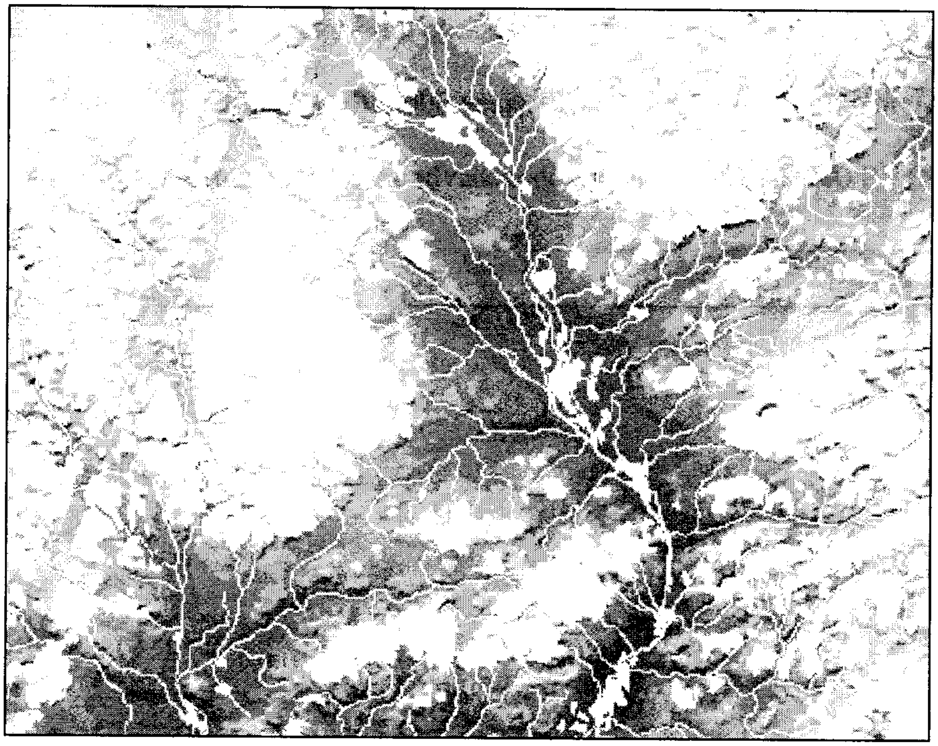


Figure 5. The Morava and Bečva Rivers (Czech Ministry of the Environment 2004)

The Bohemian massif's convoluted gorges and ridges resulted from complex tectonic folding during the Variscan orogeny. The adjoining Carpathian foredeep, on the other hand, has its origins in the cretaceous and tertiary Alpine orogeny (Havlena et al. 1967:8; Roth 1967:8). The Paleozoic (Devonian) limestone basement is visible at only location within the Morava valley (Menčík 1967:16).

Moravian environmental conditions over the last 2.3 million years (the Pleistocene epoch), as elsewhere in Europe, were determined by alternating periods of warming and cooling. The Pleistocene ended when the last warming period, around 10,300 years ago, commenced the current Holocene epoch. During the coldest cycles, huge ice sheets formed across Scandinavia and northern Russia, spreading southward over Europe

(Jochim 2002:15-16). At least eight full climate cycles have occurred in the last 730,000 years, each cycle lasting 70,000 to 100,000 years. The Last Glacial Maximum (LGM), representing the ice sheets' most recent advance, occurred at about 18,000 BP (Figure 6).

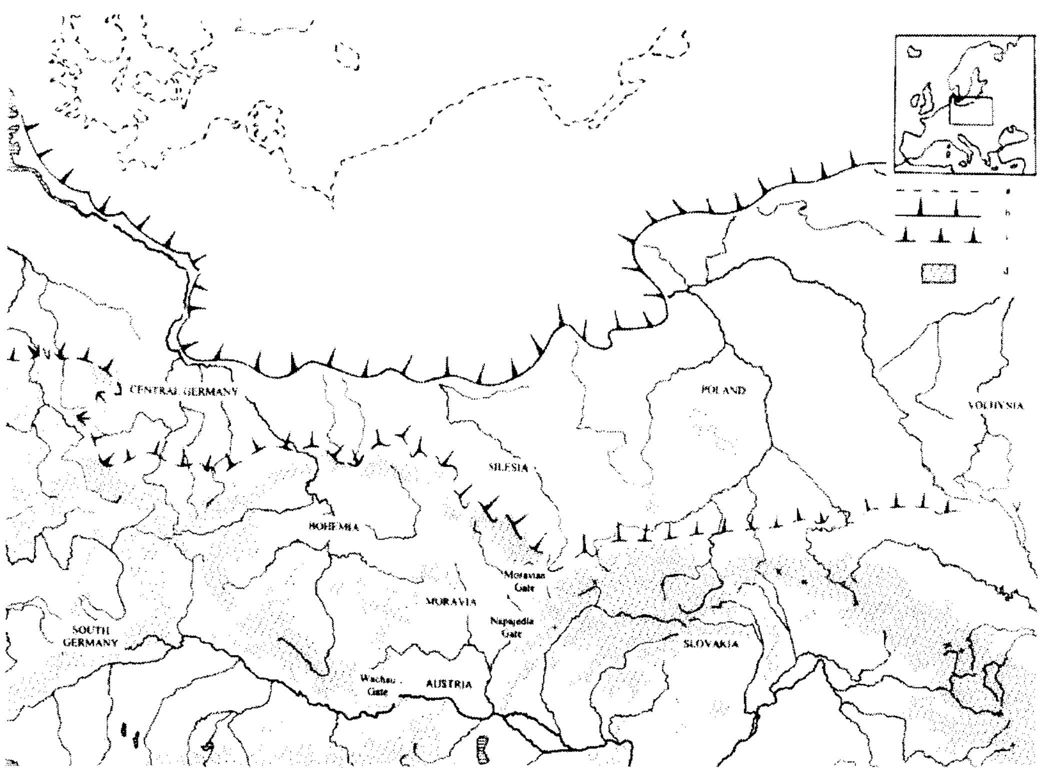


Figure 1.1. Location of Moravia in Central Europe: a—present-day Baltic shoreline; b—extension of the Fennoscandinavian ice sheet during the last glacial maximum (20,000–18,000 B.P.); c—maximal extension of the Fennoscandinavian ice sheet during the Middle Pleistocene; d—highlands.

Figure 6. Maximum Ice Coverage during LGM (Svoboda et al. 1996:2)

In general, warm "interglacial" periods were relatively temperate, while glacial periods were cold and arid. Extremes of either warm or cold climates were comparatively short and linked by a series of transition phases (Gamble 1994:17-18; Svoboda et al. 1996:16). Tundra was replaced by woodland and forest, only to be reclaimed again by arid steppes.

Fauna varied as well, and many ice-age species are now extinct. Colder conditions suited herd animals such as bison, aurochs, reindeer, and woolly mammoth, preyed upon by wolves, hyenas, and huge cave bears; warmer climates favored woodland rhino, elephants, hippopotamus, and fallow deer (Gamble 1994:19).

Climate cycles in Moravia have been traced in sedimentary and depositional soil series, especially in the southern and central regions. Thick loess soils (silty and loamy periglacial sediments) formed at the glacial margins, and were deposited throughout the Morava valley by wind and water (Svoboda et al. 1996:22-23) (Figure 7).

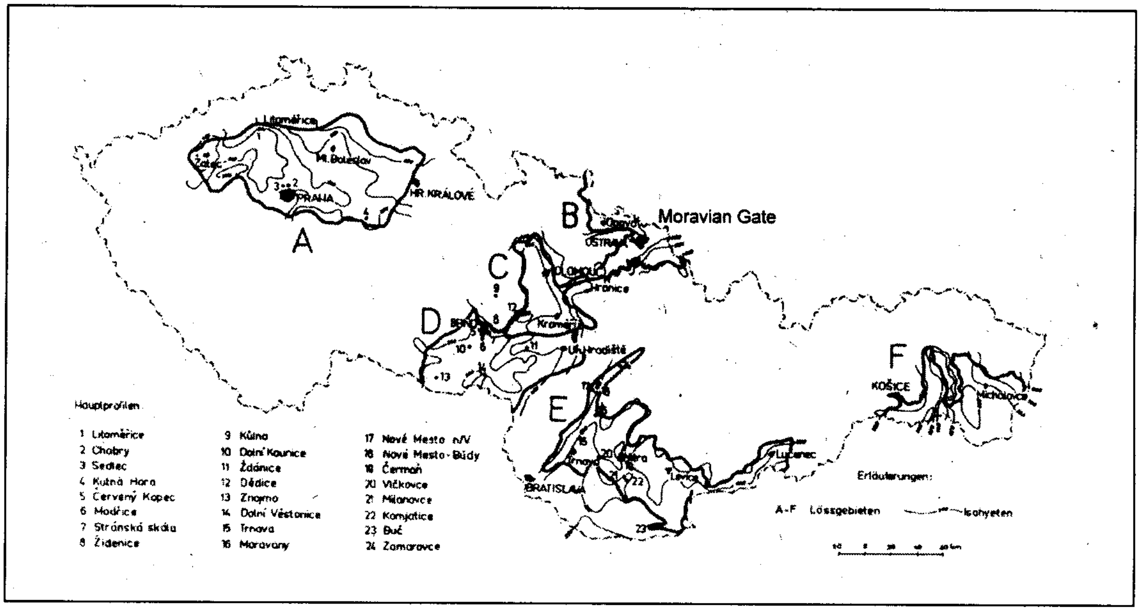


Figure 7. Loess Soils in Czechoslovakia (Kukla 1969:122)

A 50m-tall sequence of Pleistocene fluvial sediments, loess, and paleosoils exposed by quarrying activity at the Červený kopec brickyard in Brno was particularly significant for understanding climatic cycles. Paleosoils of the last interglacial are also especially well documented by the loess series at the Dolní Věstonice brickyard (Figure 8) (Svoboda et al. 1996:21). The stratigraphy established by these soil cycles was used to ascertain the complete chronology of Quaternary period warming and cooling in Moravia, reaching back nearly 1.5 million years BP (Kukla 1969).

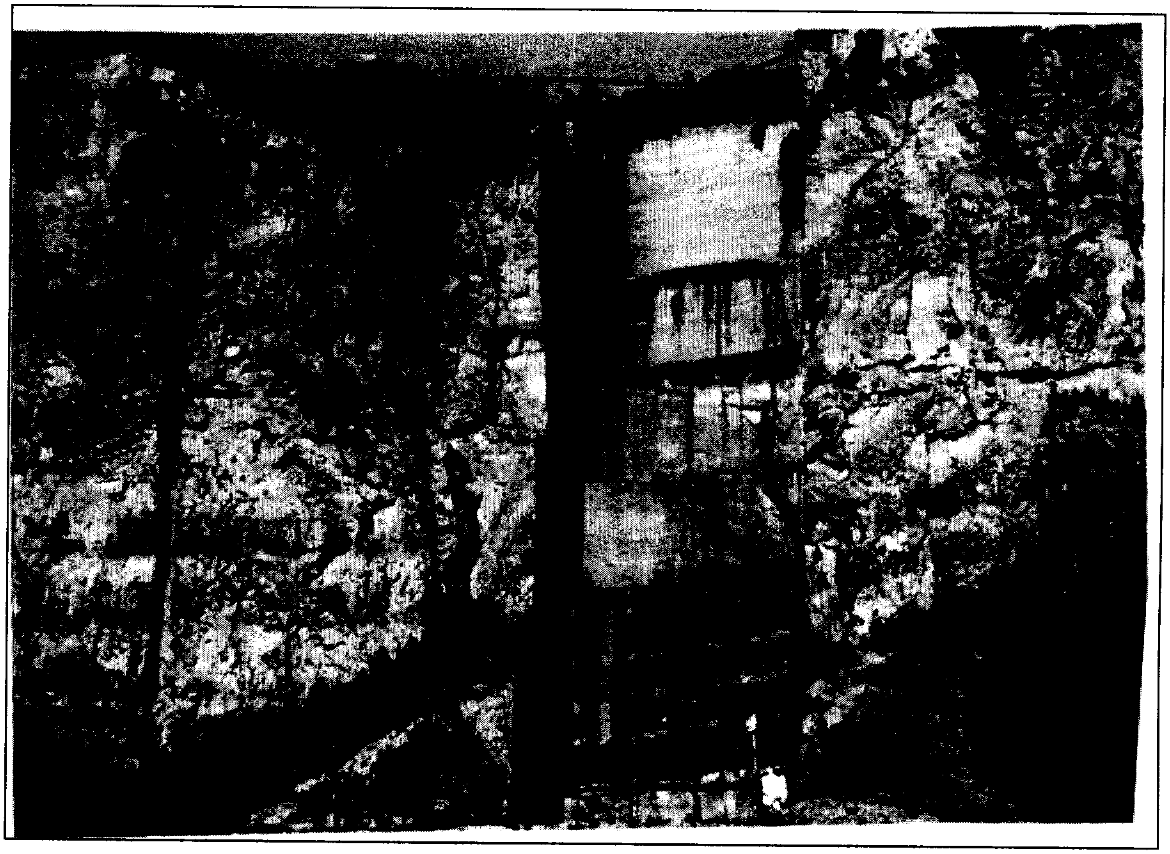


Figure 8. Stratigraphic Section from Dolní Věstonice (Svoboda et al. 1996:26)

The northern borders of Moravia essentially correspond with the maximal extension of the Middle Pleistocene Fennoscandinavian ice sheet. The great glaciers twice reached to the Jeseníky Mountains and penetrated the Moravian Gate to Hranice na Moravě. This is the only location in Central Europe where the Continental ice sheet crossed the European continental divide into the watershed of the Black Sea (Šibrava 1967:23). The Moravian

Basin thus represents a node of the ice-free passageway between the Continental and Alpine glaciers, a corridor for movement of humans and animals.

Two other major river systems (the Oder and Vistula, both flowing north to the Baltic) have sources in the low wide pass between the Bohemian and Carpathian mountain ranges. This "Broad Moravian Gate" was historically one of the most important passages between northern and southern Europe, connecting the Danube Valley and Pannonian Plain (modern Austria and Hungary) with the North European Plain (modern Poland). The actual Moravian Gate, a narrow depression near the head of the Morava's tributary Bečva, forms the continental divide separating the Baltic and Black Sea watershed drainage areas (Shackleton 1969:428). The Morava River rises at an elevation of 1380m above sea level in the Jeseníky range, and then emerges into the Moravian depression near Olomouc. The river cuts through the westernmost curve of the Carpathian Mountains at the so-called Napojedla Gate, and then flows southward to the Danube through relatively flat and even marshy land. The Morava is 362 km in length from its headwaters to the Danube, and drains an area of 26,579 square km (Kohoutek 1978:230). Rich agricultural lands result from the fertile loess soils and loams that characterize the entire Moravian depression.

Most Moravian settlements are located on or near the region's major waterways. The largest modern city directly situated on the Morava River is Olomouc, followed by Kroměříž, Uherské Hradiště, and Hodonín. Brno, the Moravian region's capitol and largest city, is located on the Morava's tributary Svratka. Other cities situated on important lines of trade and communication include Znojmo on the Dyje, and Břeclav near the Dyje-Morava confluence. The human settlement and occupation of Moravia, both historical and prehistoric, is addressed in Chapter Three.

CHAPTER 3: THE HISTORICAL CONTEXT

The development and use of watercraft has always been contingent upon the humans who envisioned the need for these vessels, mustered the resources, and built them. To understand the dynamics of Moravian logboat usage, it is necessary to explore the region's social history over a broad time frame. Throughout even such a lengthy chronological and temporal span, certain impulses and developments create long-term patterns. For prehistoric cultures, archaeological evidence provides ample clues regarding human behavior. Aspects of subsistence, social development, trade and exchange, and religion and ideology can all be deduced from the archaeological record. Written records supplement archaeology, and provide more or less detailed information that also explains human behavior. This chapter summarizes Moravian prehistory through the archaeological record, and integrates documentary evidence from historical times to investigate watercraft usage in the region.

Early Prehistory: Paleolithic, Mesolithic, and Neolithic

Exact dating for the arrival of humans on the European continent is a matter of considerable contention among archaeologists. Claims of over a million years for various flakes and worked stone pieces are controversial and dating is difficult. Likewise, there is no firm consensus for the oldest reliably dated site – variously mentioned are Gran Dolina in Spain (800,000 BP) (Jochim 2002:20), Isernia La Pineta near Rome, dated at 730,000 BP (Gamble 1994:19), and others. The massive *Homo erectus* mandible from

Mauer, near Heidelberg, Germany (600,000 BP), was long considered to be the oldest hominid remain in Europe. Archaic *Homo sapiens* skulls, dated from 400,000 to 200,000 BP have been found at locations from England to Greece (Gamble 1994:21). So-called Neanderthals (*Homo sapiens neanderthalensis*) evolved from this ancient root, appearing in Europe over a period of time from about 250,000 BP (Jordan 1999:124).

Signs of Early Paleolithic humans are scarce in the Czech Lands, as elsewhere in Europe. Several stone tools and flakes from the Stránská skála site in Brno have been dated by paleomagnetic analysis to 700,000 BP (Čižmářová et al. 1996:7). Material for these early tools is generally restricted to local stone such as quartz and quartzite, or more rarely radiolite chert or flint (Neustupný and Neustupný 1961:21). The oldest human remains in Moravia come from cave settlements containing fossilized bones as well as tools and fauna. The most significant sites are Šipka cave on the Carpathian side of the Moravian Gate, and Kůlna and Švédův stůl caves in the Moravian karst. Skull and tooth fragments of early glacial *Homo sapiens neanderthalensis*, accompanied by stone tools and flakes, were found at all three locations (Svoboda et al. 1996:47). The upper jaw and skull fragments from the Kůlna site are dated to before 38,600 – 43,660 BP (minimal C-14 datings); the child's mandible and Late Mousterian artifacts from Šipka date to the Lower Würmian glacial period (Svoboda et al. 1996:50). The mandible and teeth from two distinct adults in Švédův stůl cave near Brno date to the same period (Svoboda et al. 1996:54). The Kůlna site, where three distinct stone working complexes were identified, was especially useful in establishing a chronology for the technological development of the tool making industry (Čižmářová et al. 1996:10). Stone implements from this period consist of various points, cutters, and scrapers, fashioned both by Levallois and Mousterian techniques (Neustupný and Neustupný 1961:21).

The earliest modern humans, *Homo sapiens sapiens*, arrived in Moravia during the Würmian interglacial period (35,000 – 30,000 BP) (Svoboda et al. 1996:56). Human remains from the Aurignacian cultural horizon were also recovered from caves, the most significant being five skulls from Mladeč cave near Olomouc in northern Moravia (Svoboda et al. 1996:57). The Aurignacian and later Gravettian cultures developed specialized tools such as flat retouched leaf-shaped points, and collective hunting of big game became common. Use of more sophisticated tools allowed more articles to be produced from bone and ivory. Perhaps the most significant development during the late Paleolithic, however, was expression of artistic creativity, reflected in engravings, carvings, and artifacts such as statuettes, figurines, and jewelry.

The late Gravettian horizon (30,000 – 25,000 BP, known in Western Europe as the Perigordian) is particularly well represented in Moravia, with numerous sites including the famous "mammoth-hunter" burials and settlements at Předmostí, Dolní Věstonice, and Pavlov. Indeed, the Moravian burials are the largest sample of human graves for this period in Europe (Svoboda et al. 1996:169). This period represents the peak of technological development for Early Stone Age tool-making, culminating in slender, elongated blades crafted from carefully chosen cores of flint, radiolarite chert, and hornstone (Čižmářová et al. 1996:10).

The Předmostí open-air loess site is located on the outskirts of modern Přerov, on a terrace overlooking the Bečva River. The site commands a strategic position at the southern entrance to the Broad Moravian Gate, well positioned near the river, high enough to avoid seasonal floods, and with a wide view both up and down the valley. The main cultural layer, containing the remains of at least 25 humans, was C-14 dated to 26,870 +/-250 BP, although the deepest horizon held Achulean period stone flakes from 200,000 BP (Svoboda 2000:15,20). A single mass grave approximately 4 m long and 2.5 m wide, lined with mammoth shoulder-blades and jaws and covered with a layer of stones 40 cm thick, held at least 20 individuals, including 12 children. Five more humans were recovered from other locations in the area. Amongst the human remains were scattered bones from mammoth, polar fox, wolf, wolverine, hare, beaver, and reindeer (Svoboda et al. 1996:226). It is not clear whether the burial represents a single interment, or an accumulation of bodies over a longer term. The incompleteness of several skeletons and the irregular posture of others suggest repeated burial action. The Předmostí burial may have been a relatively permanent graveyard, indicating the settlement's long-term stability (Svoboda 2000:25).

Habitation sites, represented by hearths and workshop areas, are clustered in separate settlement units throughout the area. Artistic creativity evident on many artifacts recovered from Předmostí has been interpreted by many researchers as having religious significance or symbolic manifestations of individual and group self-awareness (Svoboda et al. 1996:157). Items included mammoth tusk and bone incised with geometric patterns, an ivory carving of a mammoth, and most significantly, a stylized geometric representation of a female figure. Much of the Předmostí site was excavated in the last decades of the nineteenth century and early twentieth century, and unfortunately many recovered artifacts, including human remains, were destroyed by fire at the end of the Second World War.

The most celebrated regional Gravettian sites, however, are clustered around the Pavlovské hills in southern Moravia, near the town of Mikulov. Indeed, the specific phenomena of advanced Gravettian material culture are named "Pavlovian" after this site (Svoboda et al. 1996:131). At least three significant open-air sites (Dolní Věstonice, Pavlov, and Milovice) are located in loess deposits on a terrace of the Morava's tributary Dyje. Radiocarbon dates for all settlements range from 31,000 to 25,000 BP (Svoboda et al. 1996:210; Bhattacharya 1977:258). The richness of the locale is truly astonishing: over one million stone artifacts were recovered from Pavlov alone (Milisauskas 2002:71). All three sites contain habitation structures, hearths, animal bones, bone and stone tools, and human remains. 13 huts were identified at Pavlov, and several larger dwellings at Dolní Věstonice (Bhattacharya 1977:259, 264). The grave of a woman and infant, covered by a mammoth shoulder-blade, was found at Dolní Věstonice, and a similar male grave beneath two mammoth shoulder-blades at Pavlov (Šibrava 1967:32). Remains totaling at least eight humans were uncovered, all but one at Dolní Věstonice (Svoboda et al. 1996:214,221). An extensive midden containing the remains of more than 150 individual mammoths was identified near the hearths (Soffer and Praslov 1993:32). The nearby site of Milovice, in a side valley leading toward the Dyje, contained an Upper Gravettian occupation dating to 25,000 – 21,000 BP. Numerous mammoth bone deposits were uncovered, as well as circular feature of mammoth bones 4 –5 m in diameter that was interpreted as a dwelling (Svoboda et al. 1996:218).

A potentially revolutionary invention, but apparently unutilized, was the firing of clay. Numerous human and animal figurines, some containing their maker's fingerprints, were discovered at both Pavlov and Dolní Věstonice. These are the world's oldest known ceramic objects; the technology did not reappear until after the ice age in Anatolia and the Levant (Neustupný and Neustupný 1961:28). Other significant art objects from these sites include ivory pendants and hair clasps decorated with geometric designs, engravings of human faces, and the famous "Black Venus" statuette of a woman with exaggerated hips and breasts (Figure 9). The statuette, measuring 11.4 cm in length, is fashioned from baked clay mixed with bone ashes and bone dust (Bhattacharya 1977:264; Svoboda et al. 1996:158).

Pavlovian settlements are generally located in areas relatively protected from wind and weather, in close proximity to water and river-courses following the north-south Moravian Gate corridor. They are characterized by extensive use of lithic raw materials from distances of several hundred kilometers, and a specialization in mammoth exploitation (Svoboda 1990:197). Pollen analysis indicates relatively temperate climate and intermittent forest at Předmostí (arboreal vegetation comprised 31% of the total sample), mostly coniferous species but also elm and beech (Svoboda 2000:19). Forest cover was likely much greater in southern Moravia in the vicinity of Dolní Věstonice, usually over 50% (Svoboda et al. 1996:137).

Figure 9. The Věstonice Black Venus (Svoboda et al. 1996:158)

Much has been written on the revolutionary changes in human society during the Upper Paleolithic – increasing use of more sophisticated tools, evidence of social cohesion and development, and above all artistic creativity, interpreted as evidence of ritual and religion (for example, Gimbutas 1982; 1991; Mellars 1994). Neustupný considered all art from the Gravettian sites in Moravia, including both rational and magical elements, to be inseparable from religion (Neustupný and Neustupný 1961:31). Depictions of game animals are particularly widespread, often with symbolic wounds or weapons, presumably to bring fortune in the hunt. The so-called "Venuses", occurring throughout Europe in a narrow time horizon (25,000 – 23,000 BP), are represented in Moravia by examples from four sites (Dolní Věstonice, Pavlov, Moravany, and Petřkovice) (Gamble 1986:324). Their precise function is unknown, though many researchers associate the Venuses with fertility rites or other ritual activity. Jochim, to the contrary, noted, "their location within sites shows no patterning to suggest that the figurines were sacred objects of veneration" (Jochim 2002:81). Evidence for bodily ornamentation and painting with mineral pigments such as red ocher was present at several sites (Svoboda et al. 1996:128); Neustupný also interpreted this as having religious function (Neustupný and Neustupný 1961:33). In any case, it is clear that Upper Paleolithic humans in the Morava basin enjoyed a rich creative and spiritual life, and successful subsistence methods.

Climatic cooling beginning around 25,000 BP (the peak of occupation at Dolní Věstonice) culminated in the last glacial maximum (LGM) from 20,000 to 18,000 BP (Jochim 2002:82). The Moravian environment became much harsher, with permafrost formation and long winters as the ice sheet moved south over the northern European plain. Significant tree growth and forest cover was virtually eliminated from all but the most southerly zones of Europe, resulting in tundra and steppe conditions over much of the continent (Mellars 1994:44). The mountains and plains of northern and central Europe have been described as a "polar desert" or "arctic desert" between 25,000 and

14,000 BP (Jochim 2002:83). Human populations, while never abandoning the region completely, took refuge in southern Europe from the glaciers.

Around 15,000 BP, the Gravettian cultures in Moravia, already substantially reduced in numbers, disappeared in an influx of "invaders" from the south and west, the so-called Magdalenians. Typical of this development was the shift from open-air settlements back to caves and rock cavities (for example Nová Drátenická and Pekarná caves in the Moravian karst) (Svoboda et al. 1996:171,174). Magdalenian culture is characterized by considerable functional differentiation of tools, mainly of flint, and often set in bone handles. In addition to knives and scrapers, many other implements such as burins, borers, saws, chisels, and barbed harpoon-heads are characteristic of the Magdalenian period (Neustupný and Neustupný 1961:30). Despite their preference for new settlement sites, the Magdalenian culture shows continuity in the use of old communications routes, particularly through the Moravian Gate region (Svoboda et al. 1996:179). With the end of the ice age, the Magdalenian cultures too gave way or evolved to meet new environmental conditions.

By convention, the Mesolithic period in Europe is considered to begin around the end of the last ice age, continuing until the onset of predominantly farming economy (Mithen 1994:79). Thus, the Mesolithic covers the period from approximately 13,000 to 5,000 BP, although dates for both transitions are quite vague. The Mesolithic was a period of intense change and adaptation for human populations, forced to react to the ever-transforming environment. As warmer post-glacial climatic conditions stabilized, the open steppes and tundra-like conditions gave way to dense forest. Diverse new fauna appeared in the forests, and many fish species populated the rivers. The archaeological record is rather sparse, consisting mainly of surface scatters that preserve only stone (Jochim 2002:117). Mesolithic settlements, in contrast to those during the Upper Paleolithic, were not located on loess deposits. With only sparse tree cover, the loess deposits did not attract game animals and were thus avoided by humans. Habitation sites were situated on sandy riverbanks and lakeshores, not only to facilitate fishing, but also to exploit fauna that congregated near water (Tringham 1971:62-63). Numerous finds of flint fishhooks demonstrate the importance of fish in the Mesolithic diet (Neustupný and Neustupný 1961:36). Although there is great continuity with the late Paleolithic period, Mesolithic human cultures created new types of stone industry, mainly geometric microliths inserted into bone or wooden handles (Čižmářová et al. 1996:15). Widespread use of the bow and arrow in Moravia is attested by many finds of trapezoidal arrowheads. Intensive and widespread utilization of a variety of natural resources set the stage for the coming revolution – the development of agriculture.

The first agricultural and farming cultures in Moravia appeared between 6000 – 5000 BC, arriving from the Balkan Peninsula via the Danube river valley and Pannonian Basin. The agricultural revolution brought about radical changes in every sphere of human life, as the accumulation of nutrition became a controlled process. The hunter-gatherers' nomadic lifestyle was replaced by settled existence, and populations increased (Neustupný and Neustupný 1961:38). The first Neolithic agricultural settlements occur simultaneously with the latest of the Mesolithic hunter-gatherers, precisely in those areas avoided by the older cultures: the rich loess deposits of the Morava and Danube basins

(Tringham 1971:68). The first farmers cultivated many cereal crops: several varieties of wheat, barley, millet, with rye appearing in the late Neolithic. Several legumes were grown as well, including peas, lentils, and beans (Čižmářová et al. 1996:16).

The earliest agricultural communities in Central Europe are characterized by Linear Pottery (*Linearbandkeramik* in German, or LBK). Childe considered Moravia to be the heart of the LBK culture area (what he called Danubian Ia), encompassing the region's main loess deposits (Childe 1929:36). Linear Culture spread quickly, as evidenced by the homogeneity of LBK pottery ornamentation throughout central Europe and as far away as Holland (Milisauskas 1978:55). In this context, Moravia was both a core area for the culture and a corridor for movement northward into Poland and westward into Bohemia.

The presence of non-local goods at many sites is evidence for the existence of trade and exchange networks. Childe noted that beads, bracelets, and other ornaments made from the shell of *Spondylus gaederopus* (a Mediterranean mussel) must have been imported from the south (Childe 1929:41). Other material, such as flint and obsidian, or the presence of finished products without evidence of local manufacture also attests to the existence of exchange systems (Milisauskas 2002:165). Given the near-total absence of roads and the difficulty of land travel, rivers must have been important arteries for Neolithic trade.

Later Prehistory: Copper, Bronze, and Iron Ages

The first copper items appeared in Moravia around 4000 BC, but were mainly used as ornaments rather than tools. Most implements were still made from stone, axes in particular, but bone was used for finer articles such as awls and fishhooks (Neustupný and Neustupný 1961:54). There is no conclusive evidence that copper was mined or processed in Moravia during this period. Copper goods were therefore likely obtained via exchange networks or brought by incoming settlers (Čižmářová et al. 1996:25).

In the late Copper Age, two entirely new cultural groups moved into Moravia. The first group, known as the Corded Ware Culture after their ceramics, arrived around 2600 BC. Although Corded Ware peoples appeared earlier in Bohemia than in Moravia, it is likely that the Moravian groups immigrated southward over the Moravian Gate from Silesia and Little Poland (Neustupný and Neustupný 1961:76). In addition to cord-decorated ceramics, this culture is characterized by stone (and occasionally copper) battle-axes (Childe 1929:146; Čižmářová et al. 1996:32).

The second cultural group to arrive in Moravia during this period is the Bell Beaker folk (around 2300 BC). Their pottery shows extraordinary uniformity over a wide area, and according to Childe marks a complete break with all previous Danubian traditions (Childe 1929:188). The origin of this culture is much disputed among archaeologists; proposed locations range from Spain to the Ukraine. In recent years, some scholars have even proposed that the Bell Beaker phenomenon was not a migration at all, but rather a "status kit" marking elites of any ethnicity, and maintained by a pattern of contact linking trade, ritual, and ideology across central and Western Europe (Renfrew 1987:86-92).

Whatever its origin, extensive remains of Bell Beaker culture are found across Moravia, most often in river valleys. Settlement sites are rare; most material culture comes from burials. Amber and gold are found in Bell Beaker graves in Bohemia, Moravia and elsewhere, attesting to the existence of long-distance trade networks (Childe 1929:191).

By around 2000 BC, Moravian metallurgists had learned to mix copper with tin, resulting in bronze. The addition of tin lowers copper's high melting point and at the same time increases its strength. The first discovery of this process was possibly related to the abundance of tin in Bohemia. Bronze working at Únětice in Bohemia (the classic site type) pre-dates that of Syria, once thought to be the diffusion center (Turnock 1988:32). Bronze was beaten or cast into many functional or decorative items. Sickles, axes, adzes, swords, and armbands are typical.

Gimbutas credited the rise of Únětician metallurgy with producing a surplus of means of subsistence, causing fundamental changes in economy (Gimbutas 1965:250). Control of the copper sources (especially those of the western Carpathians), and their location in the center of Europe allowed the Úněticians to develop a vigorous trade in bronze, amber, and gold spanning the continent. Moravian peoples played a key role in this exchange, trading copper and local tin for Baltic amber, and controlling the Moravian Gate route from the Vistula and Oder Rivers to the head of the Adriatic Sea (Figure 10).

Processed copper was traded in semi-finished ingot or torc forms, and the end buyer carried out the final working. Large copper hoards containing torcs or bun ingots dating from this period have been found in southern Moravia, all along the Morava or Dyje Rivers. The largest hoard, uncovered in Hodonín in 1893, comprised more than 600 items representing 120 kg of copper (Čižmářová et al. 1996:37). The hoards' bulk, weight, and proximity to the rivers clearly indicate the necessity of water transport for moving such cargoes.

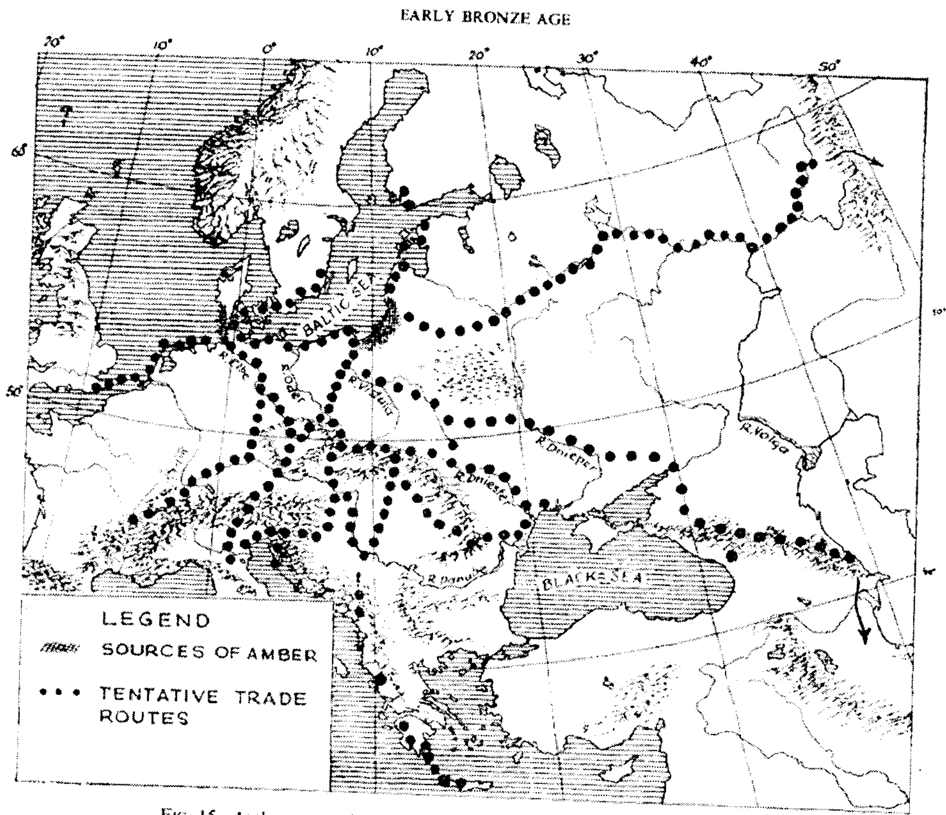


FIG. 15. Amber routes during the period between *ca.* 1600 B.C. and 1100 B.C.

Figure 10. Bronze Age Amber Routes (Gimbutas 1965:49)

One interesting aspect of the Únětice culture is the relatively frequent occurrence of wooden coffins used for burial. These coffins were made of hollowed-out tree trunks, surrounded by rocks or lumps of clay (Čižmářová et al. 1996:46). As McGrail noted, dugout logboats and coffins share many features, and one may even be mistaken for the other (McGrail 1978:19). Únětice settlements were invariably in close proximity to a water source, usually a river (Moucha 1994:60). Clear evidence of logboat burials has been noted in Scandinavia and Poland, where they were associated with amber production and transportation (Ossowski 2003:178). The possibility may exist that the Únětice culture also practiced logboat burial.

The later Bronze Age in central Europe (1300-700 BC) is often called the "Urnfield period," due to the near universal cremation rite. In central and northern Moravia, this culture (known as the Lusatian Urnfield period) lasted for several centuries, eventually blending into the early Iron Age Hallstatt Culture (Coles and Harding 1979:337; Čižmářová et al. 1996:60). Not surprisingly, all sites were located near water, usually river and stream banks or lakeshores. In Bohemia, Moravia, and especially in Hungary, Urnfield peoples settled on islands or ridges surrounded by water (Figure 11).

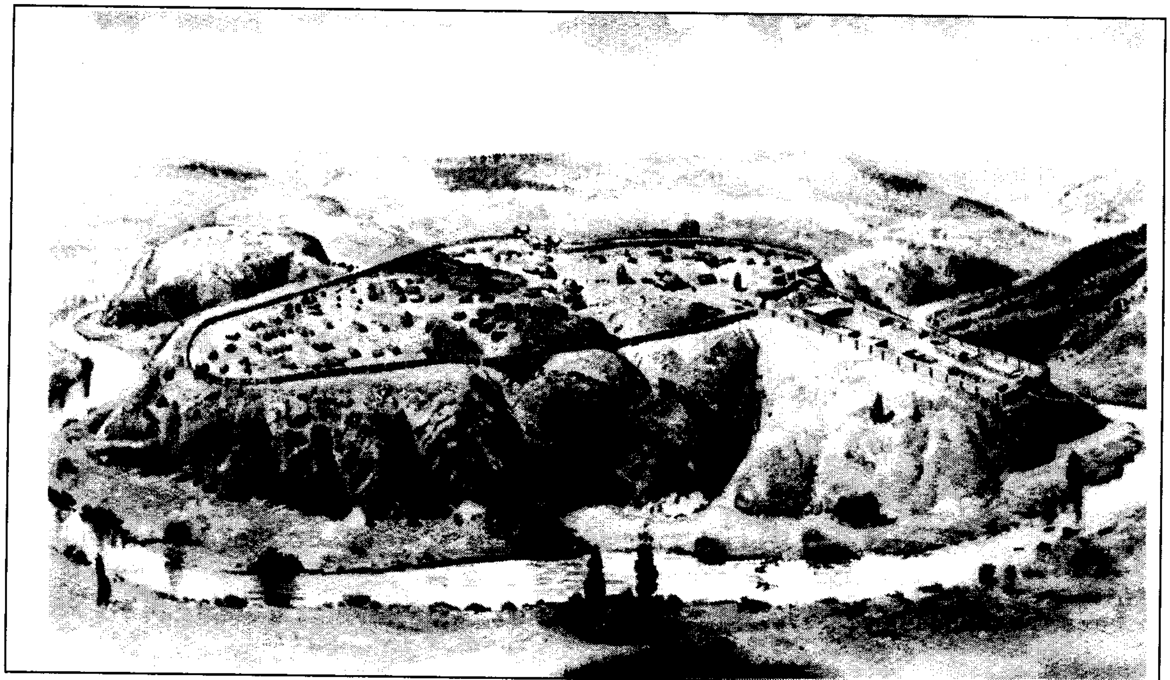


Figure 11. Moravian Hillfort (Čižmářová et al. 1996:41)

Later period sites lie almost exclusively along the great natural lines of transport (Coles and Harding 1979:341). Given the settlements' distribution and obvious evidence of trade and exchange, it is clear that water transport played a vital role in the late Bronze Age economy. More than a dozen logboats found within the late Bronze Age settlement at Wasserburg Buchau (literally "water-town Buchau") on the Federsee exemplify the daily commonplace need for these vessels (Clark 1952:287; Coles and Coles 1989:119-120).

Later Bronze Age peoples attached great ceremonial and ritual significance to bogs, lakes, and rivers, as is shown by the widespread phenomenon of "water offerings". Harding called this activity "one of the commonest practices of the European Bronze Age", attested by the thousands of artifacts deposited in this way across Europe. Modern analysis has revealed a great deal of patterning in their placement: certain objects were only left in particular environments, specific bogs or stretches of river being especially favored (Harding 2002:324). Weapons, bronzes of all sorts, and even boats were popular choices for water offerings. These leavings were almost certainly votive in nature; deposition was intended to place objects beyond control of any human agency. Weapons and war booty were often ritually "killed" by bending or breaking (Coles and Coles 1989:192-193).

Urnfield symbolism and iconography also reveals the ritual importance of watercraft. By far the most popular motifs in this period were water birds and sun symbols conjoined with boats, the "sonnen-vogelbark" (sunship bird) (Figure 12) (Coles and Harding 1979:368-369). The combined bird-head and boat design spread from Central Europe

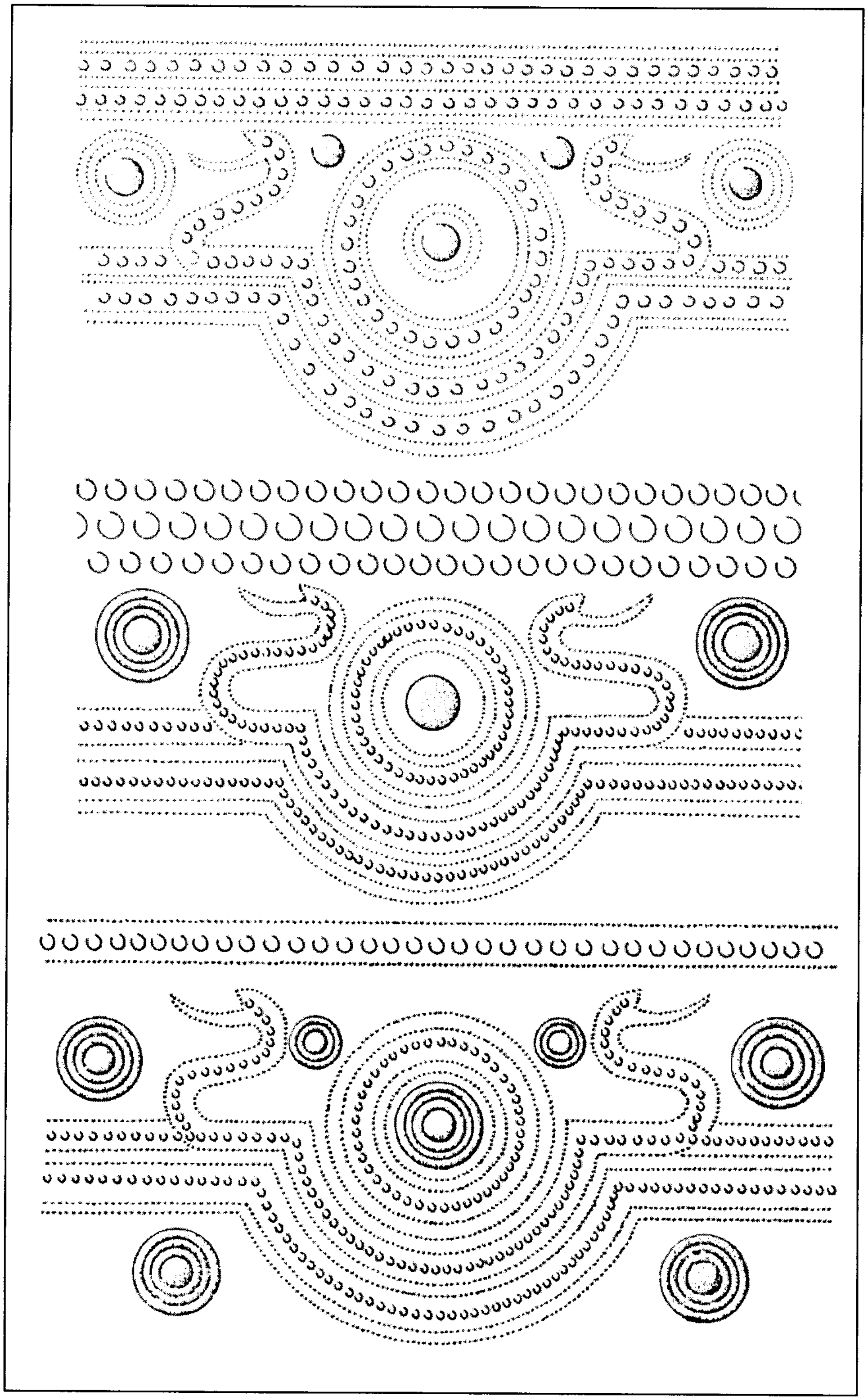


Figure 12. Bronze Age "Sunship Bird" Motifs (Kristiansen 1998:171)

to the continent's far reaches. Scandinavian rock-carvings and renderings of boats with animal-head stems are a clear expression of the long-distance influence of Central European Urnfield symbolism. Scandinavia, poor in tin and unable to process its own bronze, depended on water transport for a steady supply of that prestigious material. Boats and bronze were in this way intimately connected. According to Kaul, the ship, at least in Bronze Age Scandinavia (2000-500 BC), should accordingly be regarded "...as a dominant and positive symbol of everything related to power, religion, and external contacts" (Kaul 1998:84). In Central Europe, there is an obvious corollary: watercraft were doubly important, for not only did they carry bronze for export, but they returned with other wealth in the form of amber and gold.

Most scholars envision a long but relatively consistent transition from Central Europe's Lusatian Urnfield peoples to the early Iron Age Hallstatt Culture. Iron objects appeared for the first time around 800 BC, although iron processing did not take place locally in Moravia earlier than 600 BC (Čižmářová et al. 1996:62). Bronze metallurgy continued to thrive, and was used especially for smaller objects.

Iron contributed to new settlement patterns, as iron plowshares and colters enabled agricultural exploitation of heavy, rich valley bottom soils (Wells 2002:339). Trade expanded during this period, as growing urban centers in the Mediterranean stimulated entrepreneurial production and activity throughout Europe. Exotic items found in Moravian graves include objects from as far as the Black Sea, the Middle East, and possibly Egypt (Čižmářová et al. 1996:64,66). Amber is represented both by ornaments and jewelry in burials, and unworked stores awaiting carving or transshipment.

Another important trade good was salt, which was the economic base for the rich communities at Hallstatt and Dürrnberg in the Austrian Alps. The scale of salt extraction at the Austrian mines is ample evidence of the extensive trade systems developed around this bulk commodity. Both Hallstatt and Dürrnberg were well-placed to benefit from the long-established axis of communication leading through the Moravian gate southward to the Po Valley and the head of the Adriatic Sea (Cunliffe 1997:65-66).

The Historical Period

The time period from 400 to 200 BC brought more population movements, and new cultures moved into Central Europe. Celtic tribes expanded across Europe in several waves, settling in Bohemia and Moravia during the fourth century BC (Čižmářová et al. 1996:69). For the first time, there are written references to Central European cultures, complementing the archaeological record. Roman sources recorded the terrifying sack of Rome in 390 BC, and archaeological evidence corroborates the histories of Livy and Pliny (Cunliffe 1997:68-73). The Celtic Boii tribe settled to the west of Moravia, in the area then called Boiohaemium (Bohemia) by the neighboring Germanic Marcomanni. Another Celtic tribe called the Volcae-Tektosage likely settled in Moravian territory (Neustupný and Neustupný 1961:161).

The La Tène style, brought by the Celts on their migrations, resulted from a blending of Mediterranean influences with Hallstatt styles. La Tène decorative elements, especially curvilinear vegetal, anthropomorphic and zoomorphic motifs, are found throughout Moravia. New techniques of iron and bronze working, especially ceramic *cire perdue*, gave Celtic metalworkers freedom to explore full plastic three-dimensionality (Northover 1997:292).

Many researchers remarked on the similarities in material culture that indicate a single basic cultural unit throughout Celtic lands in the first five centuries BC. Extensive trade routes and exchange networks allowed the circulation of goods, and knit together the communities of Celtic Europe. Both raw materials and finished goods circulated widely, and low value coins became a common medium of exchange for the first time. Baltic amber continued to be an important ornamental material for high-status individuals, as well as Mediterranean coral. Finished goods from the Mediterranean, especially wine and vessels associated with wine drinking, were imported throughout Celtic Europe. Distribution of amphorae indicates the importance of water routes for transportation, barrels and skin bags were also used (Wells 1997:232). Diodorus Siculus wrote of wine exports to the Celts, "they transport the wine by boat on navigable rivers and by wagon through the plains and receive in return for it an incredibly high price, for one amphora of wine they get in return a slave – a servant in return for a drink" (Siculus in Cunliffe 1994a:414).

Celtic settlements, as noted by Julius Caesar, generally came in three sorts: *oppida* (fortified centers), *vici* (villages), and *aedificia privata* (farmsteads). Bohemian and Moravian *oppida* are generally the earliest in temperate Europe, both with extensive occupation outside the defenses (Collis 1997:161; Drda and Rybová 1998:77). The largest and most important Bohemian and Moravian *oppida* controlled the main river communication routes: Zavíst on the Vltava, and Staré Hradisko on the Morava.

Staré Hradisko functioned not only as a major depot on the amber route, but also as a manufacturing center for finished amber jewelry (Čižmář 2002:38). A rarity of finished goods and the prevalence of waste material among recovered amber remains indicate that Staré Hradisko was a large workshop location (Beck et al. 1978:348). Traces of Italian glass and Greek amphorae demonstrate the *oppidum's* connection with the Mediterranean world. Regional trade within Bohemia and Moravia also expanded, making the *oppida* the centers of commercial life.

Celtic religion is often described in similar terms to Celtic art: fantastic, wild, elegant, and deeply psychological. Shchukin called the Celtic spiritual sphere, as it appears from their art, "an unreal world, without clear boundaries between the natural and supernatural, a world composed of things without contours, of ambiguous things which change easily from one form to another, with endless variations – whether they be animal, human, or inanimate" (1998:9). One particular aspect of Celtic religion, very similar to Bronze Age cult activities, is a ritual focus on natural phenomena and sacred places. Chief among these were watery locales such as bogs, lakes, rivers, and wells. Bogs were loci for sacrifice and metalwork deposits, as were lakes and well shafts. Some scholars have advanced this interpretation for the type-site at La Tène, on Lake Neuchâtel, where thousands of weapons were found (Webster 1997:450). Waterways' importance as vital communication and trade routes certainly contributed to their sacred nature.

For reasons not entirely understood, the Celtic cultures of Central Europe sharply declined from about the middle of the first century BC. Roman invasion and occupation of large parts of Western Europe displaced Germanic tribes, who subsequently moved into Celtic regions. Romans advanced to the banks of the Main and the Danube, putting tremendous pressures on the Imperial peripheries as well as the occupied lands.

The Roman presence stimulated rapid trade-based economic growth in the lands north of the *limes*, ensured by the continued flow of amber from the Baltic south to the Adriatic. Goods imported from Italy or the Roman provinces include glass vessels, especially drinking sets, and *terra sigillata* ceramics (Čižmářová et al. 1996:82). During the Marcomannic Wars (168-180 AD), Emperor Marcus Aurelius established a frontline Roman fort at Mušov on the Dyje, fortified with deep moats and earthen ramparts. Units of the Tenth Legion, headquartered in Vindobona (Vienna), spent several campaign seasons at the Mušov fort engaging local Germanic tribes (Čižmářová et al. 1996:84-85).

It is likely that there were Roman camps deeper in Moravia. Roman bricks have been found incorporated in eighth and ninth century constructions, for example at the church of St. Michael in Staré Město, more than 150 km from the Danube (Luděk Galuška 2003, pers. comm.). Rather than transporting bricks from camps in the distant provinces, it seems more likely that the Moravians gathered them from local Roman stations still unknown (Neustupný and Neustupný 1961:174).

The Emperor Commodus concluded peace on the Middle Danube in 180 AD, and the war's end allowed consolidation of the Teutonic tribes north of the river. Repeated invasions by Goths, Huns, and other barbarians weakened the Roman Empire. During the first few centuries AD, German tribes including the Swabs, Heruls, and finally the Langobards inhabited Moravia (Galuška 1991:6). In the sixth century AD, during the so-called "Great Migrations," the first Slavs arrived in the region.

The Great Migrations of the fifth and early sixth centuries were large movements of barbarian tribes into border regions, or those areas previously controlled by the decaying Roman Empire. Regardless of the original Slavic homeland (a topic of endless argument among archaeologists and Slavicists), by the early sixth century Slavs had spread around all flanks of the Carpathian Mountains, across the Danube plain into the Balkans, into Bohemia and Moravia, and eastward into the Ukraine (Barford 2001:47). The considerable stylistic uniformity of widely dispersed early Slavic artifacts attests to the rapid pace of Slavic migration (Sláma 1991:29). It seems likely that the first Slavs in Moravia arrived there from the north, moving around the Carpathians and south through the Moravian Gate. Modern Czech scholars date the Slavs' arrival in Moravia contemporaneously with the Langobards' departure to Italy in 568 AD (Galuška 1991:11). This date agrees with the archaeological record, as the earliest Slavic pottery in Moravia dates to the middle or late sixth century (Jelínková 1989:252).

The arrival of Turkic-speaking Avar nomads in the Danubian region around 560 AD further complicated the situation. The East Romans paid the Avars immense tributes in an effort to convince them both to subdue the barbarians living north of the *limes*, and to cease raiding Byzantium themselves. The Avars, their treasury fattened with large amounts of imperial gold, established a powerful hegemony centered in Pannonia and extending over a large area of central Europe. Slavs and other tribes living in this region were obliged to pay tribute and render services to the Avar khanate. A certain amount of social and cultural integration took place, as Slavs participated in Avar military campaigns and imitated customs of the Avar elite. Mixed Slav and Avar burials and settlements are evidence of the gradual development of an Avar-Slav cultural zone. Their relations assumed many different forms, but the mutual influence was strong. In 626 AD, a mixed Slav-Avar army joined a Persian attack on Constantinople. Slavs served mainly in the infantry, but also used dugout logboats to ferry troops across the Bosporus. The Chronicle of Paschal described the attack:

> On that Sunday, the accused khagan went to Khalai [modern Bebek] and put into the sea the *monoxyla* which were to cross to the other side [of the Bosporus] and bring him the Persians in accordance with their promise. When this became known our naval vessels accompanied by light boats set out on the same day to Khalai, despite an unfavorable wind, in order to prevent the *monoxyla* from reaching the other shore...Neither on Sunday night nor at daybreak on Monday did their boats manage to deceive our watches and cross over to the Persians. All the Slavs who came in the *monoxyla* were thrown into the sea or were slaughtered by our people (Schenker 1995:18).

The Avars withdrew, and the defeat was one among many that signaled a decline in their ability to maintain hegemony over the khanate (Barford 2001:70).

From time to time, inhabitants of border areas of the khanate or regions of harsh subjugation rose in rebellion against the Avars. In 623 AD, a renegade Frankish fur and slave trader named Samo joined local Slavs in a revolt, and eventually became their leader. The rebellion was successful, and the political entity created by Samo is often cited as the first West Slavic state. The main source for this event is the Merovingian *Chronicle of Fredegar*, compiled in Burgundy in the 660's. Samo ruled the Slavic confederation from 624-659 AD, and following his death it collapsed into tribal anarchy. Although the actual location of Samo's state has never been determined, archaeological and documentary evidence points to Lusatia, Bohemia, and Moravia (Schenker 1995:22).

Whatever tribal union had been achieved during Samo's reign seems to have disintegrated after his death. Despite the lack of unity, social stratification and development proceeded, and is reflected in the archaeological record. High value items such as bronze belt-ends and hooked spurs, characteristic of societal elites, appear in burial sites from this period. Foundries and metal working shops are evidence of increased specialization by craftsmen. Settlement patterns also changed, away from semi-dugout huts built on posts characteristic of early Slavic dwellings, to large fortified "ringwall" forts (Galuška 1991:26). Ringwalls – fortified settlements surrounded by palisade walls, often on river islands – were built across a broad territory, from the Dnieper to the Saale River (Figure 13).

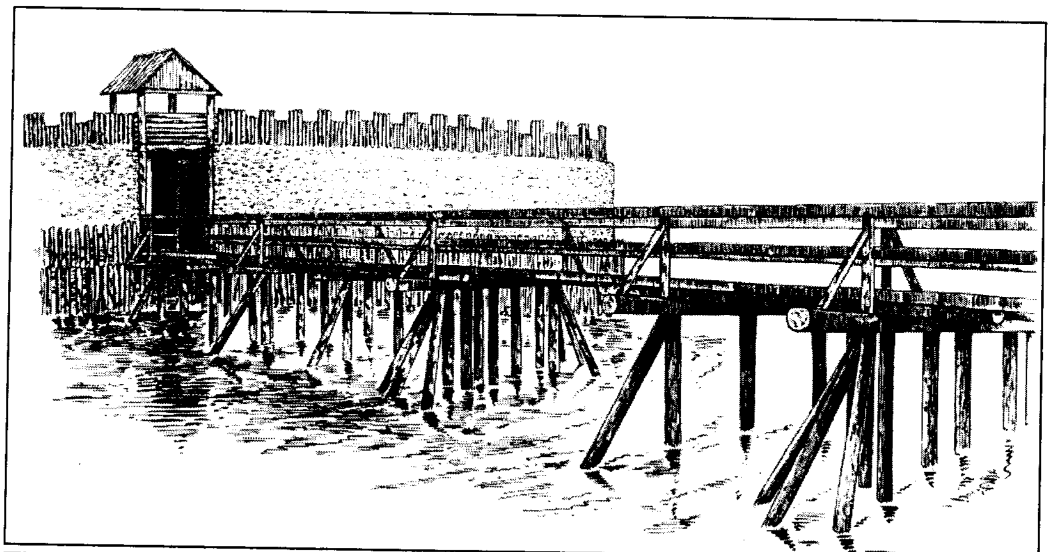


Figure 13. Great Moravian Fortress (Archaeological Institute of the Czech Academy of Sciences 2000:27)

The two largest and most well known Moravian ringwalls are the settlements at Mikulčice and Staré Město. These fortresses were well placed to control access through the Moravian Gate, as well as routes leading to deposits of various raw materials (iron ore for example).

The Avars were finally destroyed in 796 AD by the military expeditions of Charlemagne and his son Pippin. The *khagan's* fortified camp between the Danube and Tisza rivers was demolished, and Einhard reported that the Franks got more booty from this war than any other (Thorpe 1986:67). Some Avars accepted baptism and pledged fealty to Charlemagne, but most dispersed and fled (many to the protection of Krum, *khagan* of the Bulgars) (Riché 1993:109).

The Avars' departure created a substantial power vacuum in Central Europe, bounded on the west by the Frankish *Ostmark* (military frontier zone). Inhabitants of western Pannonia came under the influence of the Franks kings (who had assumed the defunct title of "Roman Emperor"), and those to the south and east were dominated by the rising Bulgarian khaganate. Between the two powers, in the Morava and Nitra river valleys, two independent Slavic principalities developed. The Slavs stubbornly fought against repeated Frankish attempts to subjugate them. The Moravian dukes Mojmír I (d. 846), Rostislav (r.846-870), and Svatopluk (r. 871-894) were able to centralize power in a series of strongholds along the Moravian Gate trade route, especially the ringwall fortresses at Mikulčice and Staré Město. In 830 Mojmír annexed the territory of Nitra, and pushed into parts of Poland, Bohemia, and Lusatia. The Moravians' rapid and skillful acquisition of territory earned them the title of "Greater Moravia" from the Byzantine Emperor Constantine VII Porphyrogenétos (Schenker 1995:25).

Weakened by repeated conflict with the Franks and fragmented by overly ambitious expansion, the Great Moravian state finally collapsed during the nomadic Magyar invasions in the tenth century. Settlements were abandoned, and political authority fragmented. The initiative in building a west Slavic state passed to Bohemia.

Historical Use of Moravian Waterways

One of the earliest documents mentioning water transport in the Moravian region is the early tenth century Raffelstetten Codex (903-904 AD). The Codex is a collection of laws regulating river traffic and tolls associated with salt trade on the Danube, and indirectly its northern tributaries. The Codex described how *naves salinariae* (salt boats) sailed down the Danube and up to the Morava to reach the *mercatum Marahorum* (Moravian market) (Třeštík 1973:874).

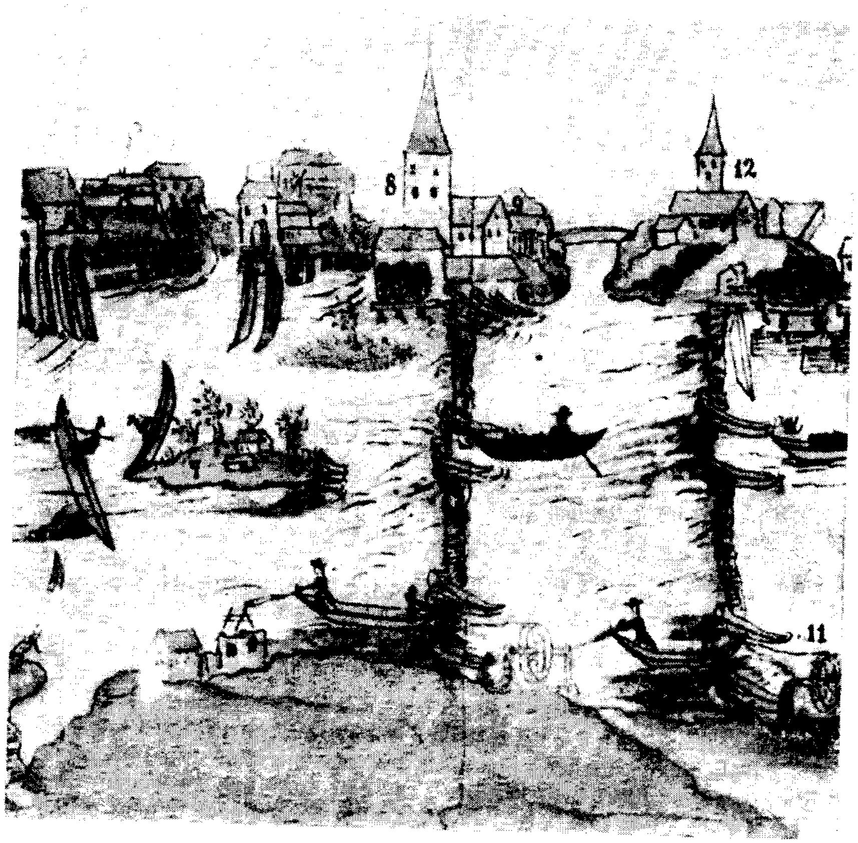
Other tenth century documents describe similar salt imports to neighboring Bohemia. The Rožmberk archive mentions rafts used to transport wood from South Bohemia to Prague on the Vltava River (Figure 14). Cargoes moved by rafts and boats on the Elbe included salt, fish, hides, honey, grain, and wine. In the twelfth century, Bohemia exported flour, beer, and building materials on the same river (Hons 1975:47-48).

Czech king (and later Holy Roman Emperor) Charles IV (r. 1347-1378) was well known for his efforts to improve long-distance trade routes to his kingdom. The

Figure 14. Raft on the Vltava River, Bohemia (Hons 1975:219)

king's pet project was a trade route from Venice to Lübeck via Prague (Figure 15). In connection with this scheme, royal engineers planned a canal linking the Danube and Vltava Rivers. According to the sixteenth century bishop of Olomouc, Jan Dubravius, work actually began on the project but had to be abandoned due to financial and technical difficulties (Jakubec 2002:23).

In Moravia, the Morava River, at least in principle, has always been navigable by small vessels below the confluence with the Bečva. During the Middle Ages, two groups of people who made a living from the river (boatmen and millers) came into conflict. The millers' repeated construction of dams and weirs on the river, intended to raise water levels for mill-races, created obstacles to navigation. Finally, in 1542, the Moravian assembly passed a decree, proclaiming that "measures shall be taken by anyone who



Obr. 13. Plavby lodi přes pražské jezy v 17. století (výřez z první panoramatické mapy Vltavy)

Figure 15. Seventeenth Century Bohemian River Boats (Hons 1975:50)

constructs weirs on the river such that the Morava shall be freely navigable during times of adequate water flow…for boats or for transportation of timber or other goods…under penalty of a fine of 100 groschen" (Jakubec 2002:24). The situation apparently did not improve, and in 1579, the Estates General of the Margravate of Moravia appointed a special commission to investigate poor navigational conditions on the river. Millers were again strictly enjoined from hindering the flow of traffic on the river, and the Estates mandated "windows" during which the weirs were to be opened to allow navigation (Hons 1975:53).

Nearly a century later, in 1653, the Moravian Estates first raised the question of joining the Morava and Oder Rivers via a navigable canal. The Imperial Salt Authorities in Vienna sought cheap methods of distributing Austrian salt in Bohemia and Moravia (Hons 1975:48, 53). A proclamation was issued in the name of his Imperial and Royal Majesty Ferdinand III, Emperor of Austria-Hungary, King of Bohemia, and Margrave of Moravia, stating that improvement of navigation was a matter of "common usefulness and good," and would "improve trade with neighboring lands, and expand business and commerce" (Jakubec 2002:25). The Emperor hired one Filibert Luchese, an Italian architect, to study the problem. Luchese identified many obstacles to navigation, including 15 weirs, numerous shoals, and concentrations of logs, tree trunks, and snags. Luchese's plan to straighten and deepen the Morava's main channel was never realized, mainly due to the expense: despite using free labor of peasants under corvée obligation, his plan cost 93,000 gold ducats (Hons 1975:54). The late seventeenth century Ottoman attacks on Vienna and Moravia killed Luchese's plan for good.

The eighteenth century brought further attempts to improve navigability in Moravia, often associated with plans to join the Danube and Oder Rivers via the Morava. One such attempt was undertaken by a certain Lothar Vogemonte (Lothario à Vogeso Monte). Vogemonte, on the basis of his canal-building experience in the Low Countries, managed to get himself appointed advisor to the Imperial Court in Vienna. In 1700 Vogemonte published his "Dissertatio de Utilitate, Possibilitate, et Modo conjunctionis Danubii cum

Odera, Vistula, & Albi Fluviis, per Canalem Navigabilim" (Dissertation on the Usefulness, Potential, and Methods of joining the Danube with the Oder, Vistula, and Elbe, by a Navigable Canal) (Vogemonte 1700). Vogemonte's scheme called for two canals: one connecting the Bečva with the Oder near Nový Jičín, and another between the Morava and Elbe Rivers (Figure 16). The canals would thus link Vienna with both the Baltic and North Seas, via the Morava River.

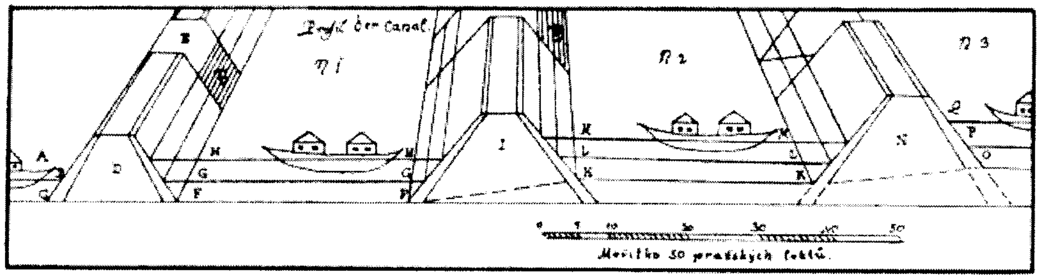


Figure 16. Lothar Vogemonte's Planned Morava River Locks (Hons 1975:58)

After careful study, the Bohemian Assembly approved the plan, and in 1711, Emperor Leopold I granted Vogemonte a ten year Imperial *privilegium* (exclusive concession) for purposes of constructing his canals. The *privilegium* went unused, however, and in 1721 another petitioner, Norbert Vencl von Linck, succeeded in building a single locks chamber at Rohatec. The first two vessels passed through the locks in May 1722, each loaded with 260 quintals of salt (Hons 1975:54). In a familiar scenario, the War of Austrian Succession interrupted plans for further construction.

The next successful improvement to navigation on the Morava came in 1785, when Emperor Josef II granted Jan Rochus Dorfleuthner of Hodonín a 20-year *privilegium* for navigation on the Morava (Jakubec 2002:26-27). Dorfleuthner, a timber merchant, constructed a stone locks chamber at Hodonín and operated vessels on the river between Veselí and the Danube confluence (Figure 17). Loads included wood, salt, grain, and fruit (Hons 1975:55). Dorfleuthner's enterprise was nonetheless short-lived, and his *privilegium* too expired.

Figure 17. Horses Towing Riverboats Upstream (Hons 1975:49)

A private joint-stock corporation, "The Morava River Navigation Company," formed in Brno in 1807 with the intention of operating regular cargo service on the Morava. The company maintained a navigable channel slightly shorter than Dorfleuthner's, between Hodonín and the Danube confluence. Relatively large flat-bottomed vessels transported cargos of coal, timber, and tobacco downstream. A team of two horses was required to pull each vessel back upstream to Hodonín, a five-day journey (Hons 1975:55). The company planned to construct 19 locks over a 4-year period, using 2000 laborers. Once again the required funds failed to materialize, and the state took over maintenance of the Morava channel from Hodonín to Děvín at the Danube confluence (Jakubec 2002:27).

A variety of legislative proposals and proclamations were introduced over the course of the nineteenth century, both in the Imperial parliament and regional assemblies, regarding works on the Morava. Proposals generally aimed to improve navigation, provide irrigation water, and mitigate damage resulting from regular flooding (Figure 18). The "Imperial Water Law", passed by the Vienna parliament in1869, declared

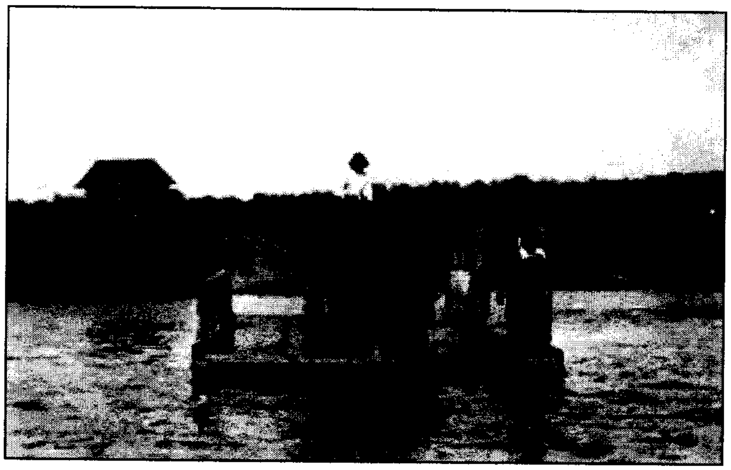


Figure 18. Morava River Ferry (Bat'a Canal 2004)

"all rivers and watercourses…which are suitable for navigation by boat, raft, or other watercraft...[to be] public property" (Gallina 2002:15). The following year, the Moravian assembly adopted the same wording for "The Moravian Water Law." Despite numerous attempts by private entities, the government financed most work and river maintenance in this period.

State efforts were mainly aimed at preventing flood damage during high water. Starting in 1818, workers deepened the main channel and cut through meanders to straighten the river's course. Thus severed from the main river, some of the meanders dried out, but many remain to this day as oxbow lakes (Figure 19). Heavy damage

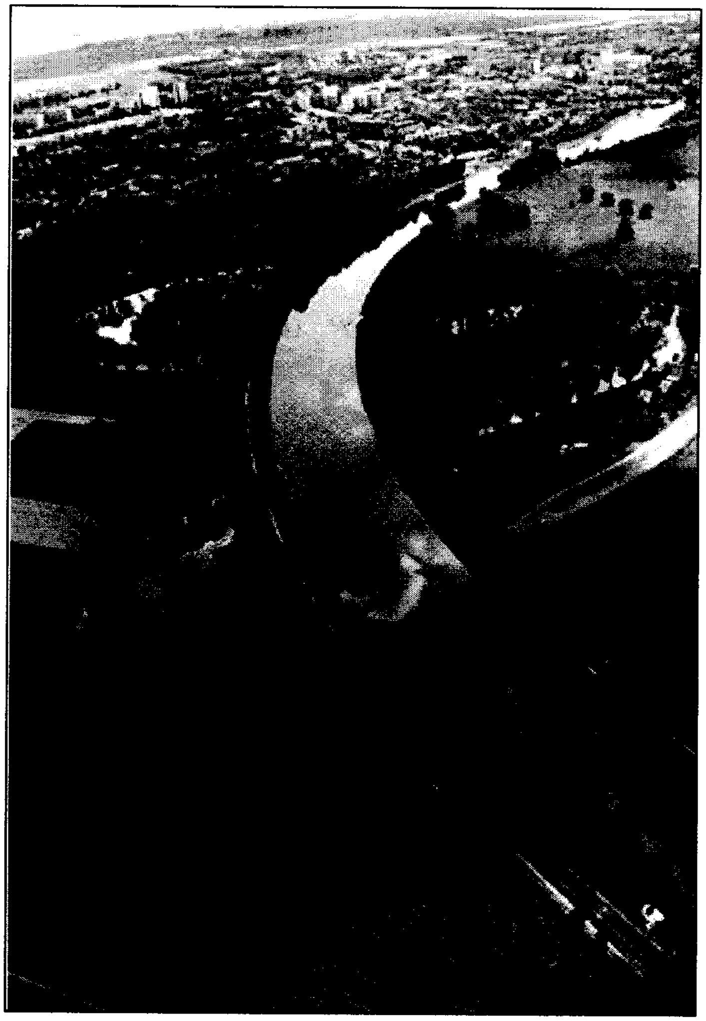


Figure 19. Morava River and Oxbow Lakes near Veselí (Bat'a Canal 2004)

resulting from flooding in 1875 and again in 1880 intensified efforts to regulate the river's flow (Jakubec 2002:28). In 1901, the Vienna parliament passed the "Water Transportation Law," intended to finalize plans for flood protection in combination with a Danube-Morava-Oder canal. Budget problems postponed construction, as did the onset of the First World War. Finally in 1934, construction began on a canal intended to provide irrigation for the area around Strážnice.

At the same time, the Bat'a Company needed a way to transport coal from mines near Hodonín some 35 km upriver to factories in Otrokovice and Zlín. Company founder and owner Jan Antonín Bat'a chose multi-use canals as the most economical and efficient possibility. Bat'a absorbed the bulk of the project's cost, with a sizable contribution from the state funds for productive employment (the project employed up to 1500 workers during a time of intense economic crisis). Work commenced in October 1934, and finished in autumn 1938 (Figure 20).

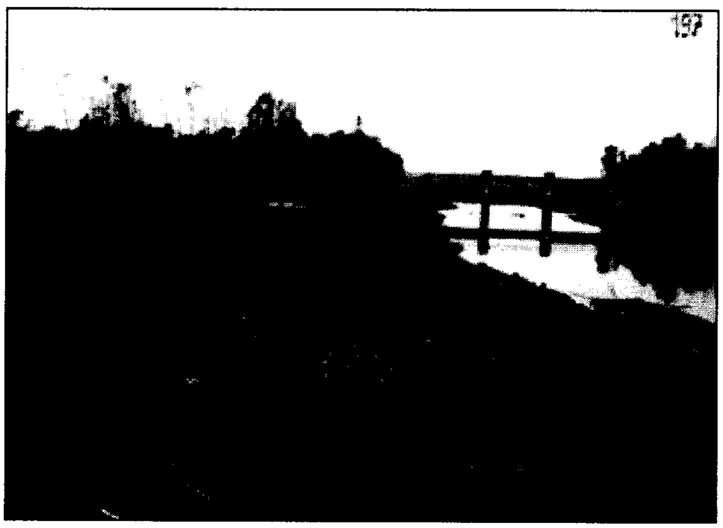


Figure 20. Construction on the Bat'a Canal at Vnorovy (Bat'a Canal 2004)

The route ran through 14 locks of various sizes, from the docks at the Baťa's Otrokovice factory to the coal loading facility in Rohatec (Figure 21). A combination of horses (later tractors) and tugboats towed 150-ton barges both ways between the mines and the factory, a 10-hour journey under ideal conditions (Vojtěch Bártek 2004, pers. comm.).

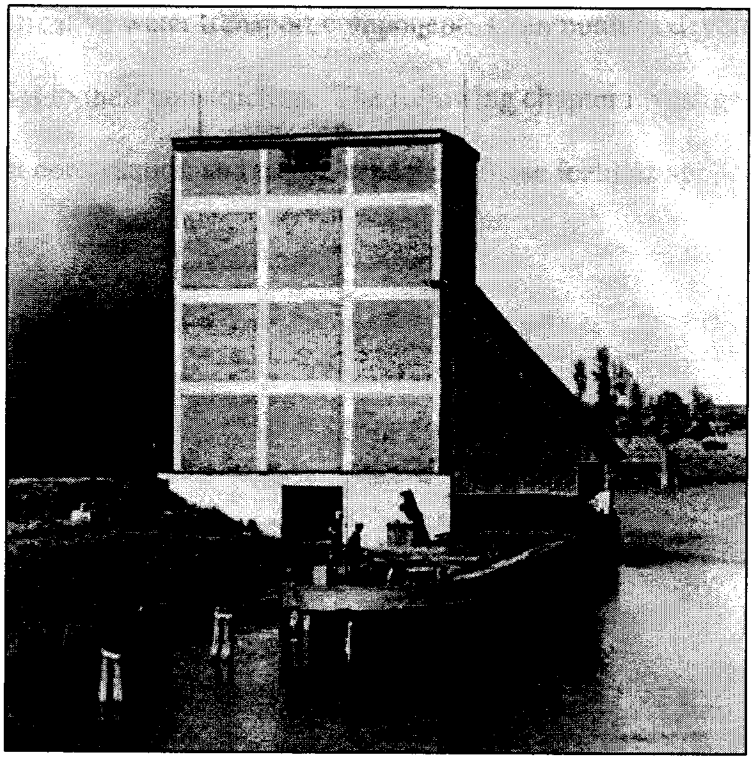


Figure 21. Coal Loading Facility at Rohatec (Bat'a Canal 2004)

The Baťa canal survived World War II nearly unscathed, and sustained damage only in the war's final days in 1945. The canal was re-opened in 1949 after repairs, although canal transport was gradually replaced by rail (Hons 1975:264). The canal's technical condition deteriorated to such a point that safety authorities closed the canal in 1970. In the early 1990's a group of engineers, historians, and enthusiasts renovated locks and passages in hopes of reopening the canal. Their dream was realized in 1995, when the Czech Parliament passed the "Zákon o vnitrozemské plavbě" (Inland Navigation Law), declaring the canal serviceable and open for recreational use.

This chapter demonstrates the utility and necessity of water transportation in Moravia throughout history. For much of the temporal span of human habitation, logboats were an integral and effective water transport component. Communities devoted significant time and resources to their construction. The following chapter investigates practical aspects of dugout construction and usage, especially those features applicable to Moravian vessels.

CHAPTER 4: THE STUDY OF LOGBOATS

Humans and Watercraft

Moravia's historical context, as described in Chapter Three, demonstrates the utility and need for watercraft in the region. This need is shared by human societies around the world. The current chapter briefly discusses general watercraft development, and specifically the study of dugout logboats.

Since the earliest days of human society, watercraft have played a significant role as a reliable (and sometimes sole) method of travel and communication. Early humans, sometime over one million years ago, spread from their African place of origin to eventually inhabit every continent save Antarctica. Moving northward, they reached the temperate zones of Eurasia. It is unreasonable to suppose that they crossed every lake, river, swamp, and sea encountered along the route by swimming. Development of watercraft was essential for the spread of the human species. It is likely that early vessels were initially used simply for fording rivers or streams, and for obtaining nourishment via fishing and hunting. The similarity of early Stone Age sites in North-west Africa and South-west Europe led Paul Johnstone, among others, to suggest that the first sea voyage in human history was across the Straits of Gibralter (Johnstone 1980:3).

There are many possible modes and vehicles used for trade and transportation. Local, regional, and long-distance trade may each have separate needs and requirements. A human on foot may carry valuable, low-bulk trade goods. Bulkier, heavier, or higher volume cargo may require wheeled carts. In the absence of roads or suitable terrain, such cargoes were almost certainly moved by water (Teigelake 2003:155). Extensive water travel developed along with trade, commerce, and warfare. The continents became interlaced with networks of trade routes following navigable rivers. Even where waters were not navigable, river valleys presented ease of movement by foot or pack animal. Fords and other locations where land routes intersected with rivers became important crossroads and settlement sites. Archaeological evidence reflects the importance of rivers as arteries of prehistoric trade, for example, transcontinental amber routes or trade in raw materials such as flint (Clark 1952:282). Naturally, water transport was most extensively employed in coastal areas and inland regions well endowed with rivers and lakes.

The first human watercraft was likely a floating tree trunk or branch, although there is no evidence to prove this supposition. Voyages would be extremely difficult on such un-worked logs, though they could certainly spark the impulse to deliberately fashion similar (and more convenient) "craft" for use on lakes, rivers, and seas. Development of more advanced craft, however, would require tools and time beyond the scope of Lower Paleolithic hunters.

Constructing a logboat with a Mesolithic or Early Neolithic tool kit was undoubtedly a tremendously time-consuming operation. This is illustrated by modern ethnographic parallels: according to Johnstone, Carib Indians "spent entire years making their boats, while the Maoris, having chosen a suitable tree, planted a crop near by so that they could live off it the following year while hollowing out the felled trunk" (Johnstone 1980:46). It seems to have been necessary for a group to achieve a degree of stability and settled existence before engaging in such work. It was traditionally assumed that while stone tools may have sufficed to work softwoods, metal tools would be required to work hardwoods such as oak (McGrail 1978:36; Johnstone 1980:46). Reappraisal of this view occurred after discovering Stone Age vessels, for example, ten Neolithic period oak dugouts found at Paris-Bercy in 1991-1992 (Barthez et al. 2000:119). Recently, experimental archaeology has shown that stone axes and adzes can be used on oak with significant success (Tichý 1999:49).

In any case, a community would need to devote significant resources to construct a logboat, with enough nutritional surpluses to feed the specialists who worked on it (Greenhill and Morrison 1995:102). Trial and error, repeated experimentation, and design success or failure would result in a large body of knowledge accumulating in a community. The collective learning would necessarily be passed from master to apprentice lest it be forever lost. Thus, a relatively high level of social development, group cohesion, and technical advancement are prerequisites to logboat construction.

Typology and Terminology

Boats, as opposed to floats or rafts, derive flotation and buoyancy from the displacement of water by a continuous watertight outer surface (McGrail 1998:5). A conceptual distinction between boats built as a *waterproof shell* or as a *waterproof frame* has long been recognized (Greenhill and Morrison 1995:47; McGrail 1998:5). The former are usually referred to as *shell-first construction*, the latter *skeleton-first* or *frame-first* construction. In any general classification of watercraft, dugout logboats may be described as *shell-built by reduction*, i.e. the original raw material (a tree-trunk) is hollowed out and reduced in volume, leaving a waterproof shell. Reduction, as opposed to junction or molding, is still used in ship construction for shaping stems, aprons, and deadwoods (McKee 1983:44). To construct a logboat, the trunk may be either whole or split longitudinally. The log interior is hollowed out, and the exterior may be shaped to improve hydrodynamic efficiency. McGrail identified several variants of the basic logboat, comprising *expanded*, *extended*, and *paired* versions (McGrail 1998:56). Other researchers refer to the basic logboat as a "hard" canoe, i.e. hollowed directly from the log, and those vessels expanded and molded by heat as "soft" (Rausing 1984:10). In northern Europe, basic logboats are called "trogförming" (trough-form), and expanded vessels "schotenförming" (pod-form) (Clark 1952:284).

To improve seaworthiness and increase freeboard, planks or strakes could be fastened along the vessel's sides. As more strakes were added on either side, the original dugout torso became a log keel or plank. This evolution can be seen on the eleventh century Utrecht boat (Van de Moortel 2000:9), the fourteenth century Kentmere boat (McGrail 1998:75), and even relatively modern vessels such as Bangladeshi riverboats or Pomeranian plank boats (Greenhill and Morrison 1995:111-114). Alford described Carolina "split-dugout canoes", made by splitting the tree trunk and inserting a plank down the vessel centerline to expand area and cargo capacity (Alford 1992:201). As all vessels addressed in this study appear to exhibit only basic logboat characteristics, these developments will not be further addressed in any detail.

Building Dugout Logboats

Building a logboat starts with selecting a suitable tree. Ideal timber for a logboat has straight grain, little taper, durability, relatively easy working characteristics, and no "shakes" (internal damage to the wood fiber from wind and weather). In addition, the tree should be situated where it can be easily felled in proximity to a watercourse (McGrail 1978:117). Many researchers have commented on the constraints raw material places on logboat design. Without addition or expansion, the builder can do nothing to fundamentally alter the height, breadth, or beam of a dugout vessel. Fewer limits are placed on length, although vessels with an excessive length to breadth ratio are quite unstable and handle poorly in the water. Fry observed that, "...whereas makers of planked boats are able to fit raw materials to suit the particular design of their craft, makers of single-piece hulls are obliged to adapt the design to the material at hand" (Fry 2000:14).

All vessels in this study are fashioned of oak (*Quercus* sp.), which appears to be the wood of choice for most European logboats. In comparison with other species, oak has the best combination of size, grain pattern, strength, workability, and durability, making it the nearest to an ideal material for constructing dugout vessels (McGrail 1978:118). Archaeological evidence corroborates this observation. In his early study of British logboats, Fox stated, "the wood out of which the canoes were hewn seems to have been almost invariably oak," and mentioned as the exception a single vessel made from ash (Fox 1926:131). Interestingly, two of the oldest recovered European logboats, from Pesse in the Netherlands (6315 BC) and Noyen-sur-Seine in France (7960+/-100 uncal

BP), were made of pine (Mordant and Mordant 1992:61). Elm, the preferred species for British warship sternposts and keels due to its rot resistance when immersed in water (Lavery 1984:29), rarely shows up as dugout building material. Keller's early work on Swiss lake logboats mentioned one 6m "einbaum" made from poplar; the rest were oak (Keller 1878:228). Paret's catalogue of continental European finds reported 58 oak vessels from a total of 62 boats (Paret 1930). Mowat reported that 87% of the surviving Scottish vessels were oak; the figure was 96% for English and Welsh boats (Mowat 1996:126). Fry did not provide a summary of species used for logboat construction in Northern Ireland, although his formula for evaluating performance used the specific density of green oak (Fry 2000:29). The preponderance of discovered oaken vessels may also be a result of that species' greater durability and resistance to decay; oak simply survives better in the archaeological record (McGrail 1978:118).

Modern studies of continental European vessels mention other species used in logboat construction, although oak still prevails (Arnold 1995; Okorokov 1995; Ossowski 1999). Lime (*Tilia* sp.) and alder (*Alnus* sp.) predominate in Stone Age Scandinavian dugouts (Christensen 1990:122). These species are easier to work than oak, but oak is more durable. The 9.5 m boat from Tybrind Vig, dated to 3310 BC, was fashioned from lime (Anderson 1983:172), as were three Swiss logboats dating from the sixth millennium BC (Arnold 1993:5). Austrian vessels investigated by Angerer (1927) and Kunze (1968) were made from fir and spruce. McGrail noted archaeological evidence from across Europe of ten species (including oak) used for logboat construction (McGrail 1998:60).

Following selection of appropriate timber, the log was cut to length. To best avoid cracking and checking, wood is generally worked in a green unseasoned state, ideally in the winter months. Even today, foresters and woodcutters in the Czech Republic have a cutting season of November through March (Ladislav Vlček 2003, pers. comm.). Ethnographic evidence suggests that the boat was likely designed and drawn on the log prior to beginning work. In areas of Poland where logboat usage continued well into the twentieth century, a full-size template was used to inscribe plan and profile views onto the log as a guide for cutting (Ossowski 1999:52). There is debate as to whether the outside was shaped before the inside was hollowed, and there may well have been two different approaches. McGrail thought it likely that working the interior and exterior was alternated, particularly if thickness gauges were used (McGrail 1998:61). To create thickness gauges, holes were bored into the bottom of the vessel to the desired depth, equal to the intended thickness of the vessel's floor. After interior hollowing, the holes were plugged with dowels or treenails cut flush with the surface. There is also variation regarding the use of fire in hollowing logboat interiors. Ethnographic parallels provide evidence both for and against use of fire in the hollowing process, although fire does not necessarily leave archaeological traces (Johnstone 1980:47). Christensen maintained that wedges were used to split off large portions of wood between transverse notches, and mentioned a half-finished example from Germany in which a wedge was found still jammed in the wood (Christensen 1990:136) (Figure 22). If a vessel were to be expanded, heating and steaming the sides is an essential part of the process. Following the primary shaping process, final fittings (if any) could be worked and secured.

Adzes, axes, and hatchets were used for cutting and rough shaping. Excavating the log's interior was the most difficult and time-consuming part of logboat construction. Mallet and chisel may be used for this task; the essential tool for hollowing timber, however, is the adze. The narrow inward curving blade is perfectly suited for final shaping of both interior and exterior surfaces (Figure 23).

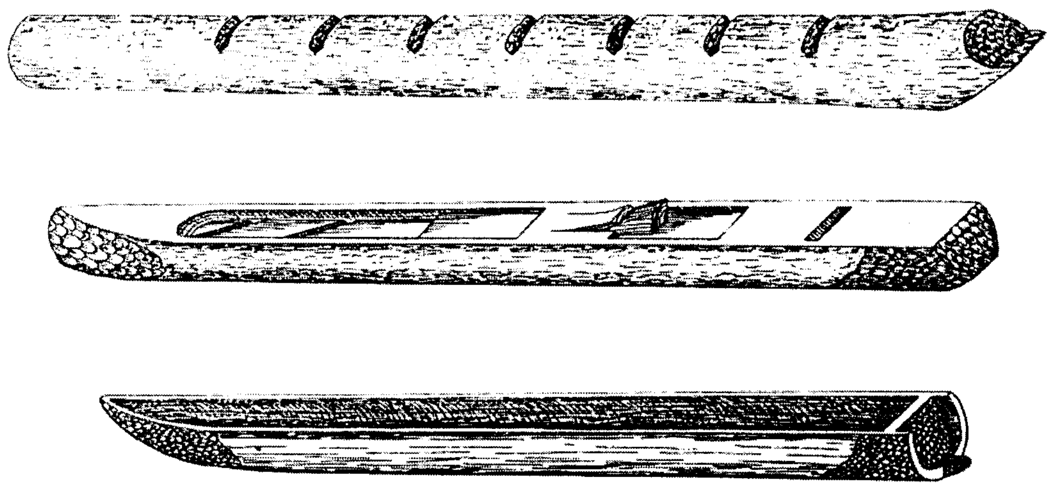


Figure 20. Method for reconstruction of a dug-out boat (drawn by Eva Koch Nielsen).

Figure 22. Logboat Construction Sequence (Christensen 1990:136)

Analysis of tool marks on the Clapton logboat (c. 950 – 1000 AD) showed that at least two iron adzes were used in construction, one with a rather narrow blade width of 38 mm, and another wider blade of about 67 mm (Marsden 1989:99-100). Adzes of stone and metal were used in Europe; ethnographic accounts from Polynesia report adzes fashioned from giant clam (*Tridacna*) shells used for dugout construction (Hornell 1948:46).

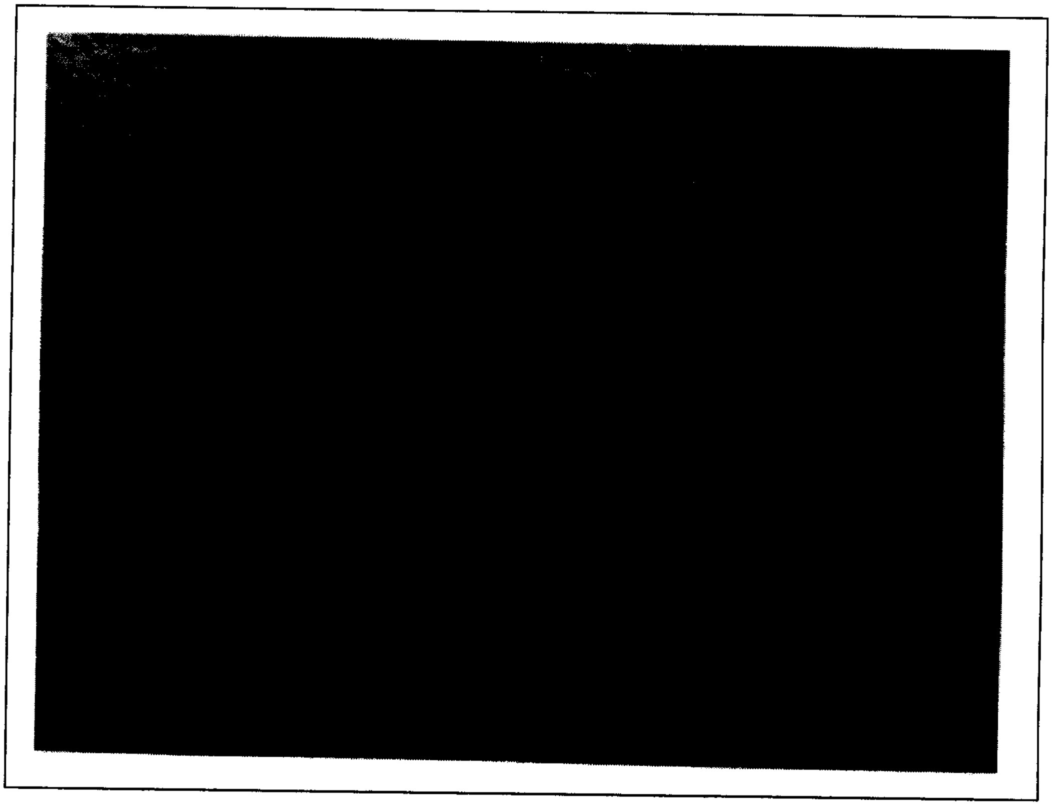


Figure 23. Adze Marks on Logboat Interior (Christensen 1990:130)

The total time taken to build a logboat varied with the number of builders, type of wood being worked, vessel size, toolkit sophistication, etc. In his study of twentieth-century logboats on Austria's Mondsee, Kunze reported that vessels were often stored underwater for at least one year prior to final working (Kunze 1968). McGrail cited ethnographic accounts from South America where building a vessel took from 17 to 78 man-days (McGrail 1998:64).

Tichý calculated 300 hours for constructing the 9m experimental oak dugout vessel his team built in 1998 (although felling the tree was accomplished with a modern chainsaw) (Figure 24). Building this vessel was particularly demanding: to obtain the best results from the timber, the team worked outside through the winter months, sometimes in raging snowstorms (Tichý 1999:50). Hrala, citing "recent ethnographic evidence," suggested that creating a monoxyl vessel, including timber seasoning, preservation, working, and finishing could take as long as 30 years, and thus the boat was likely intended for the succeeding generation (Hrala 1969:815).

Figure 24. Experimental Logboat Under Construction (Tichý 1999:50)

Dating Dugout Logboats

According to McGrail, "Dating [logboats], with few exceptions, is poor. Until relatively recently, logboats have generally been presumed to be prehistoric and dates attributed on the flimsiest of stratigraphic or associative evidence" (McGrail 1998:58).

Early attempts at dating logboats by appearance alone assumed that early vessels were crude and primitive, and that later ones were well fashioned and more sea-worthy (Fry 2000:9). After the advent of absolute dating methods, this assumption was proved false. Early logboats can be extremely sophisticated, reflecting both the skill of the builders as well as the vessels' significance to the community as a whole. Thus, it is impossible to date logboats accurately by morphological or typological comparison, corroborative evidence is always required. Given typical circumstances of discovery, i.e. dredging, construction, or floodwaters, logboats frequently lack reliable context or datable associated elements. Radiocarbon (C14) dating, and dendrochronological analysis of a logboat timber itself are often the only means of obtaining reasonably accurate dates for these vessels, and both have their drawbacks. C14 dating, once calibrated into calendar years, is accurate only within a fairly broad range, sometimes as much as several hundred years. Dendrochronology (tree-ring dating), on the other hand, can pinpoint an exact year and even a season for cutting the tree (Michels 1973:115). In order to achieve this, a species-specific chronology must already be established for the region, and a sample representing a substantial number of annual growth rings is required (the more rings, the easier it is to fit the sample into an established sequence). Unless the sequence is extremely clear or conspicuous, a sample of less than 25 or 30 annual rings is undatable (Michels 1973:119). Logboats, by their very nature, are essentially hollow shells, only the ends or features such as full bulkheads contain more than a few annual rings. Even where dendrochronological dating is possible, some have argued that this accuracy is wasted on logboats: "There is no need to know the date of a dug-out to this level of precision…there are some objects which simply do not need precise dates" (Baille 1982:241).

Ritual and Ceremonial Significance of Logboats

The social context of early logboat manufacturing and usage is extremely poorly understood. Van de Noort noted that early Bronze Age vessels in Great Britain show a clear distribution pattern: sewn-plank boats are found along the coast or in intertidal environments, while logboats are found predominantly in lakes and rivers. The implication is that sewn-plank vessels were used for seafaring, and logboats were intended virtually exclusively for inland navigation (Van de Noort 2004:406). In this context, sewn-plank boats were interpreted as having close association with ancestral rites and elite long-distance exchange networks, while logboats, presumably, were strictly utilitarian in nature. While early sewn-plank vessels are so far unique to Great Britain, it is worth noting that no pre- or early historic planked vessels of any sort have been found in the Czech Lands. In Poland, Ossowski determined that the evolution from logboats to plank boats took place along the coast by the ninth century AD, and on inland waterways between the thirteenth and fifteenth centuries (Ossowski 1999:221). It is likely that similar or even later development took place in the Czech lands, situated still further from the coast.

Ritual boat-burials are well known in Scandinavian, North Germanic, and other cultures (for example, the Viking sites at Oseberg and Gokstad in Norway, and the Saxon site at Sutton Hoo in England). It is likely that such ceremonial use of boats was practiced much earlier, dating at least to the Mesolithic. There is evidence for ritual deposition of Stone Age logboats, particularly in connection with votive offerings, sacrifices and internments, from sites across eastern Denmark, southern Sweden, and the island of Gotland (Skaarup 1992:52). In several wet-site instances, skeletal remains were found inside or alongside dugout vessels containing burnt offerings and held in position by sticks thrust into the mud around the boat (Christensen 1990:123) (Figure 25).

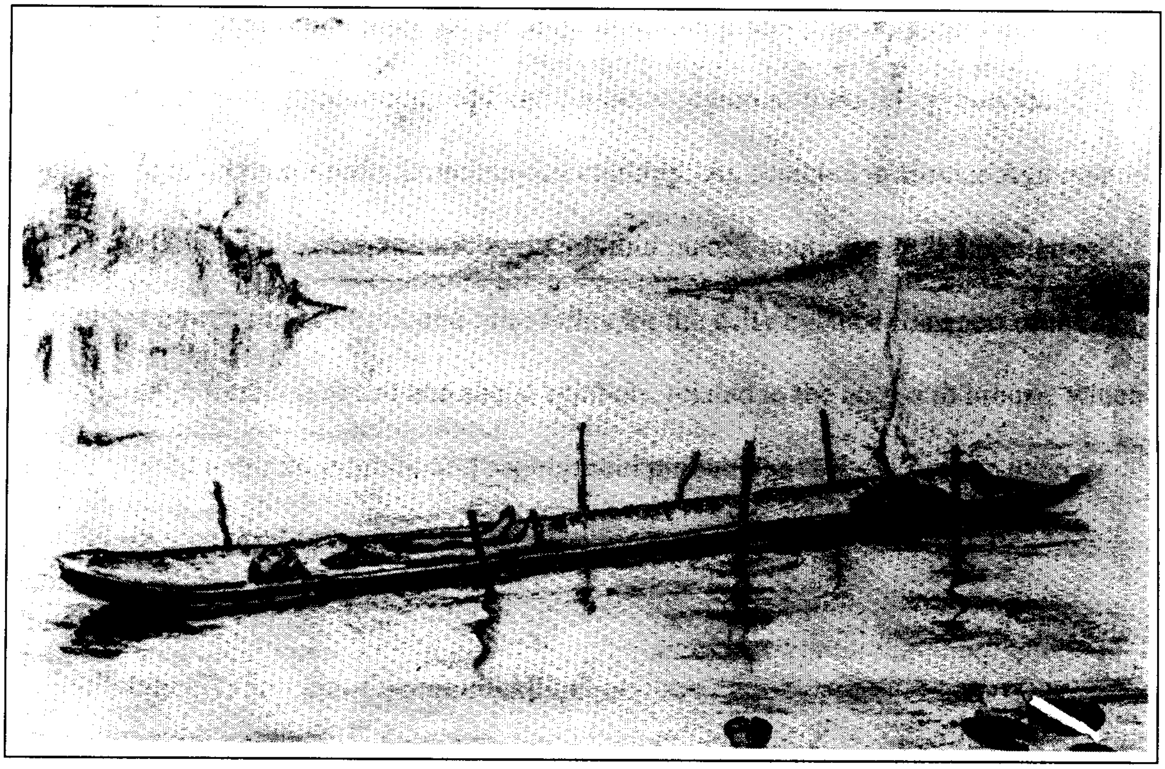


Figure 25. Logboat Burial (Christensen 1990:127)

Other terrestrial gravesites were surrounded by soil disconformity and boat-shaped contours that were interpreted as remnants of dugout logboats (Skaarup 1992:53). Clay vessels and burnt offerings were found in connection with several logboat depositions, both with and without human remains.

There is evidence for logboat burials as late as the second century AD along Poland's Baltic coast, where they are associated with amber production and transportation (Ossowski 2003:178). Similar ethnographic evidence from other parts of the world prompted Skaarup to suggest that "...there has been a universal religious conception behind the boat burials, both on land and at sea, of the boat being a well-suited means of transport for making the journey to the kingdom of the dead" (Skaarup 1992:57).

A wealth of iconographic sources from the same region also sheds light on the significance of boats for early Scandinavian cultures. As depicted in Bronze Age rock carvings and on bronze objects such as swords and razors, boats can be interpreted as symbols of power and strength, and as vehicles for the daily cyclical transport of the sun. Ships were "powerful political and social symbols, related to the access to bronze, which in itself played a role in symbolizing prestige and probably giving the right to exercise political authority and to perform or direct religious rituals" (Kaul 1998:84).

Long-distance Trade and Communication

Communications routes originated in a natural landscape, where humans were but an element of the larger animal world. Humans as well as animals utilized these corridors. The physical conditions of a region's setting determined, to a great extent, the course of passage through the landscape. Entire networks of prehistoric movement were thus based on geographic predisposition (Květ 2002:6-8). Due to ease of access, routes commonly developed along river valleys and watersheds, especially where the headwaters of one system came near the source of a second. Flows of traded materials were constrained into channels. Settlements, both prehistoric and historic, often developed along major transport routes. Trade routes, to a large extent, determined the prosperity and economic development of areas through which they passed (Sherratt 1998:22).

The major transport and trade routes passing through Moravia were related to long-distance movement between northern and southern Europe. The Morava River valley was utilized as far as the Bečva, and thence over the low divide to the Oder River's upper reaches. A secondary corridor led east and west, connecting Bohemia, Moravia, Slovakia, and the Pannonian Plain. This route was particularly important in historic times, connecting Prague, Brno, and Bratislava (respectively the capitol cities of Bohemia, Moravia, and Slovakia) (Květ 2002:11-13). This route also utilized the Svratka, Morava, and Danube waterways.

Amber (fossil resin) provides perhaps the most persuasive evidence for long-distance trade in prehistoric times. As early as 1885, chemical tests on amber from Mycenaean graves indicated a Baltic origin. Modern techniques of infrared spectra measurement and neutron activation analysis can even potentially identify specific amber sources in the Baltic region (Harbottle 1982:35). Amber comes in various qualities: transparent, cloudy, osseous, etc., each containing a larger or smaller number of air bubbles. Ancient peoples valued transparent amber with a minimal amount of air bubbles above all (Du Gardin 1993:132-133).

Amber was not only worn as jewelry, but used in medicaments, burnt during ritual ceremonies, and used for protection against diseases and bad magic. Ancient writers spoke of amber in connection with solar deities, especially the "Hyperborean Apollo" (Bouzek 1990:141). Amber's supposed solar qualities may imply a connection with Scandinavian and Central European "sunship bird" symbolism. The substance's protective power and magic made it extremely valuable: a single boatload of Baltic amber was worth a fortune in the Mediterranean.

Amber is widely distributed in graves and settlement sites throughout the Czech lands, but especially along the Moravian Gate route leading south from Poland and the Baltic Sea (Květ 2002:23-25). Raw amber stores at the Staré Hradisko *oppidum* were so great that the location was known from the sixteenth century, and J.A. Comenius marked it on his 1627 map of Moravia as "Hradisco, ubi myrrha effoditur" (Hradisko, where myrrh is found) (Čižmář 2002:8). Gas chromatography analysis in the late 1970s definitively proved that amber from Hradisko is in fact Baltic, and not related to local fossil resin deposits (Beck et al. 1978:343).

Many researchers have described the role of water transport in long-distance trade and travel. Water is by far the most efficient medium for transporting cargoes of nearly every type (Bass 1972:9). In almost every case, it is faster, easier, and cheaper to move loads by water than by land. Dugout logboats found along the Morava River must be seen in the context, not only of local riverine resource exploitation, but also medium and long-distance trade, travel, and communications.

Despite the obvious importance of watercraft in the Moravian region, almost no archaeological vessel investigations have taken place. The following chapter summarizes all previous research carried out on Moravian dugout logboats. Significant site investigations and related finds are also discussed. A description of all known vessels is provided, including circumstances of discovery and current location.

CHAPTER 5: MORAVIAN LOGBOATS – PREVIOUS RESEARCH AND CATALOGUE OF VESSELS

Previous Research

Moravian dugout vessels have received only meager investigation, due in part to the small number of finds and lack of conservation. The earliest scholarly mention of Moravian logboats was in 1951 by B. Novotný in his article "Nejstarší plavidla na Českych vodách" (The Oldest Watercraft on Czech Waters) (1951). This piece focuses on monoxyls discovered in Bohemia, and mentions the Moravian vessels only tangentially. The first scholar to write specifically about Moravian dugout vessel finds was Dr. Vilém Hrubý of the Czechoslovak Academy of Sciences, Institute of Archaeology. In his article "Staroslovanské čluny na našem území"(Early Slavonic Watercraft in Our Land), Dr. Hrubý described several possible monoxyl remains, two of which were recovered and conserved (1965b). Hrubý's descriptive information was generally good, although measured drawings were provided only for the two recovered vessels.

The discovery of several logboats at the Great Moravian citadel of Mikulčice in 1968 generated new interest in these vessels. Excavations at this site have been ongoing since 1954, under the auspices of the Czechoslovak Academy of Sciences, Institute of Archaeology, and directed mainly by Josef Poulík, Zdeněk Klanica, and recently Lumír Poláček. Two complete boats and fragments of another were recovered (with some difficulty), conserved, and placed on display. The Mikulčice vessels were first described in the project's annual fieldwork report in 1968 (Klanica 1968), and received scant mention in Poulík's authoritative summary (1975:134). A fourth vessel was discovered in 1984, but due to its extremely fragile condition was recorded and left *in situ*. Ongoing excavations resulted in a backlog of data and artifacts, and it was not until 2000 that Dr. Lumír Poláček published a complete description of the Mikulčice vessels (2000).

In 1999, interest was renewed by the discovery of a new logboat near the northern Moravian town of Mohelnice (Jaroslav Peška 2003, pers. comm.). Radiocarbon dating was performed, and the vessel was conserved using advanced up to date techniques. The Mohelnice site awaits further investigation.

Catalogue of Vessels

A complete catalogue of the Moravian vessels, including circumstances of discovery, current location (if known) is provided below. Vessels are listed in alphabetical order by site name. Vessel plans are provided in Appendix B.

Kostelany.

Dr. Vilém Hrubý stated that in 1947 he came upon interesting remains in Kostelany nad Moravou, approximately 100 m south of the Morava River bridge (1965b:128). Pieces of "blackened, worked wood" were turned up by a work crew's excavator. The workers informed Dr. Hrubý that the wooden remnants came from "the main river-course", and had been found approximately 2 m below the existing riverbed. The fragments were chopped up by the work crew and used as firewood.

Dr. Hrubý was convinced that these wood fragments were remnants of an old vessel; his suspicion was strengthened when workers told him that the previous year, while excavating in the river for sand, they came upon a large boat carved from a single oak trunk. They pulled the vessel from the riverbed with a mechanical excavator. It lay on the riverbank for a time, approximately 500 m south of the Morava river bridge, and was an object of curiosity for Kostelany's inhabitants.

Eyewitnesses provided only approximate measurements, estimating the boat's length as anywhere from 4 m to 7 m. The remarkable thing about this find is that the vessel was completely encircled by a metal band just below the gunwale. The metal surface was discolored, red-brown in some places and green or blue in others. The bow and stern points were completely covered by metal, and were joined down the lengths of both sides by metal strips. At approximately the vessel's mid-point, on either side, the metal strips encircled a round socket in the boat's side. The metal was fastened to the vessel by small bronze nails with irregular rounded heads and squared shafts. There were two transverse ridges on the interior floor of the vessel, one near the bow and one near the stern. The floor at the stern was carved out deeper than the rest of the bottom, as if prepared as a sitting-place.

Two ceramic vessels dating from the Hallstatt period (early Iron Age) were recovered from the sandy riverbed at the same time as this vessel, although Hrubý doubted a connection between the finds. After an unspecified time, local inhabitants stripped the metal from the vessel and discarded it in the river. The dugout itself was then chopped into pieces (Hrubý 1965b:128).

Lideřovice.

In July of 1922, Hrubý found a monoxyl projecting from the right bank of the Morava river, just below the Lideřovice railway station. The river was unregulated then, and erosion exposed the vessel's bow, while the stern and floor remained buried in the mud. Dr. Hrubý noted that the river's water level was low during this period, and that the site would normally be submerged. The vessel was carved from a single tree-trunk, and was "completely blackened by the water". The pointed bow curved up, and there was a fairly blunt chine on the sides. The floor was flat and level, and there was a definite angle inside where the sides met the bottom. There were two holes through the bow, at the upper part of each side where the sides came together to form a point. Near the bow, a large solid bench-like ledge tapered from its base to the top and extended from side to side (Figure 26).

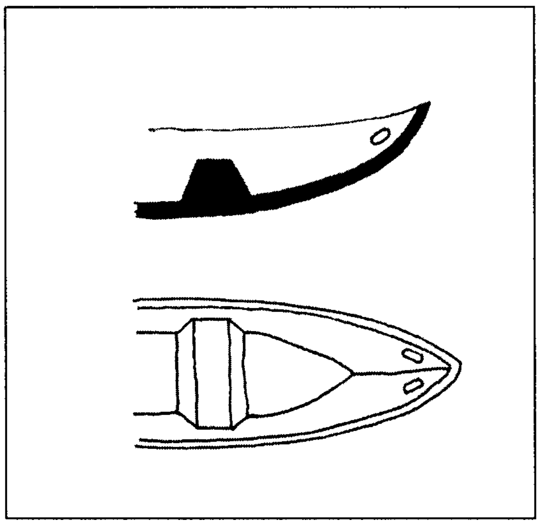


Figure 26. Lideřovice Vessel Bow (conjectural) (after Hrubý 1965b:124)

The top of the ledge did not quite reach the top of the vessel's sides. The boat's outer form approximated the original shape of the tree trunk from which it was carved. After several years, railway employees completely excavated the vessel from the riverbank, and set it out to dry. After it fell completely to pieces, they burned it in the station's restaurant (Hrubý 1965b:124).

Mikulčice vessels I-IV.

Excavations of the Great Moravian citadel near the modern village of Mikulčice started in 1954 and continue to the present day. The fortified settlement, which reached its peak during the eighth and ninth centuries AD, was situated on two large islands in former meanders of the Morava River (Figure 27).

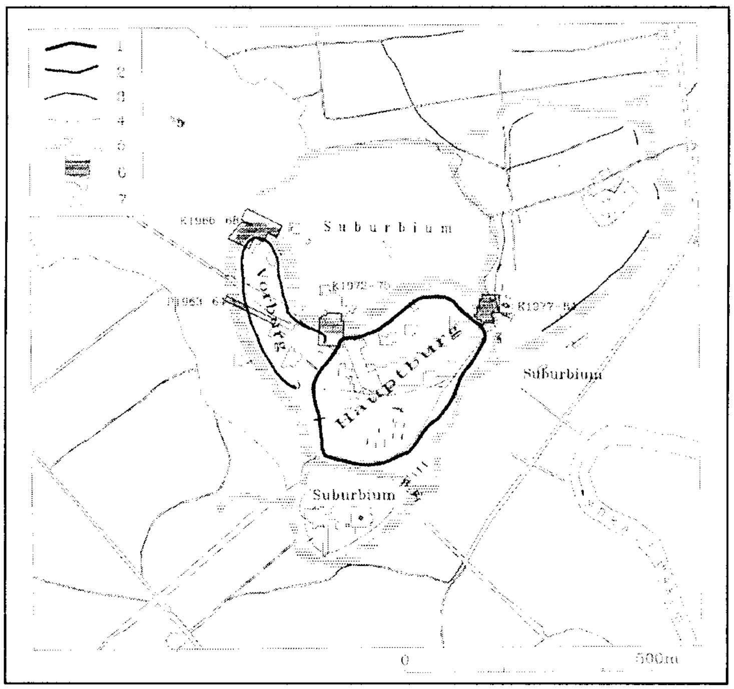


Figure 27. Mikulčice Site Map (Poláček 2000:180)

More than five hectares of land have been excavated, producing literally hundreds of thousands of recovered artifacts. Among the discoveries were four monoxyl logboats and an assortment of related objects such as paddles and fish-traps (Archaeological Institute 2000:36). All four vessels were oak (*Quercus sp.*) (Poláček 2000:203). The only Moravian vessels to be recorded as a result of planned archaeological excavation; they are described in detail below:

Vessel I.

During the 1967 season, the citadel's northwest entrance was uncovered. Excavations revealed a causeway across an earlier arm of the Morava River, leading to a gate in the fortress wall. The bow of a dugout boat was found in an older stratum of river sediment on the island inside the palisade. The annual fieldwork report described the find thus:

> Archaeologically, the first vessel is the most significant. It was located in square KB-19, at 157 m above sea level. Most interesting, the find was situated behind the outer palisade on the inside of the citadel. A cut through the ramparts revealed that they were not built on the elevated rise, but rather on older river sediment. This means that the fortified wall changed position along with changes in the river channel. The vessel lay beneath both phases of the stone wall, and beneath two layers of ash and charcoal (burned remains of the wooden palisade), therefore between the wooden palisade and the settlement site (Klanica 1968:62-63).

The huge Mikulčice fortifications were constructed of two timber ramparts with both vertical and horizontal elements, filled between with clay, and fronted by stone walls (Figure 28) (Procházka 1989:292). It is possible that the logboat was recycled and used as building material, and thus was incorporated in the palisade wall. The fragment, (inventory number K-666/67), was 283 cm in length, 75 cm in breadth, and 26 cm high

(Poláček 2000:206). There was an 11 cm high transverse ridge curving from wall to wall, 75 cm aft of the bow. A large crack ran lengthwise from the tip of the bow to the aft end of the artifact. The piece was conserved using Poly-ethylene Glycol (PEG), and is displayed in the museum of the Mikulčice National Cultural Monument. At the time of the author's visit (July 2003), it had broken into several virtually un-recognizable fragments.

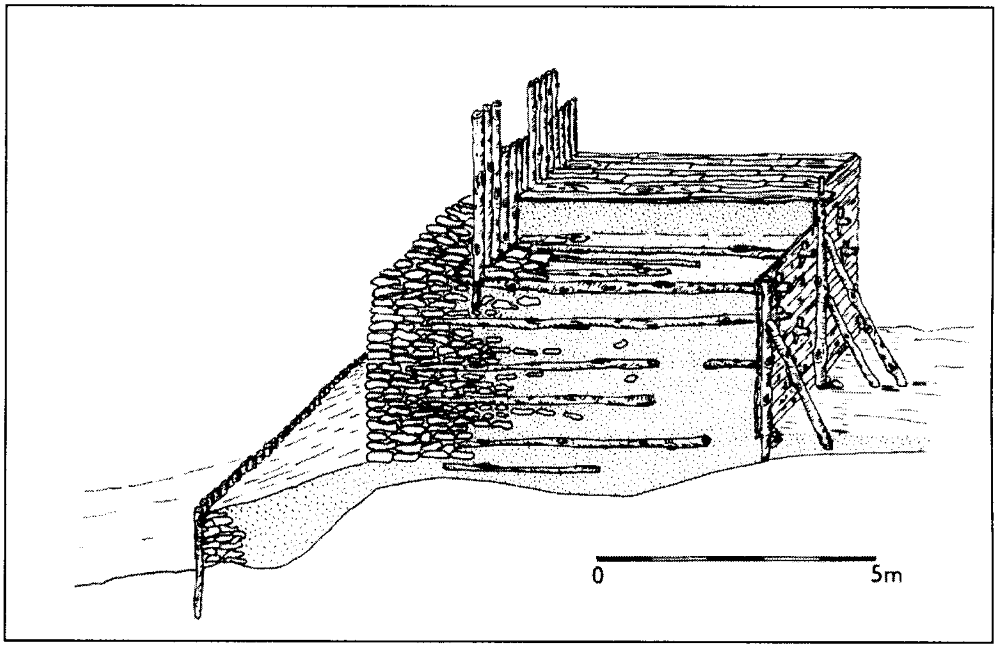


Figure 28. Mikulčice Palisade Wall (Procházka 1989:290)

Vessel II.

Also uncovered during the 1967 season, two large, well-preserved dugout vessels were lodged against the causeway pilings. They were pointed the same direction and completely covered in river sediment. The first of these (K-884/67) was 8.83 m long, with a maximum width of 66 cm, and 36 cm high (Poláček 2000:204). The boat's cross-section profile was a wide U-shape, sloping to a V-shape at both ends. The ends were extended by small platforms, and a square hole approximately 8cm per side went through the bow platform. The vessel had two curving transverse ridges, located 2 m and 5.6 m from the bow. The vessel was conserved in PEG, and is currently on display in the museum of the Mikulčice National Cultural Monument.

Vessel III.

The second vessel found in the causeway, K-1212/67, was located immediately under the first, lodged against a bridge piling. It was 9.88 m in length, 71 cm at its broadest point, and 45 cm high, making it the largest vessel found at Mikulčice. The floor was evenly partitioned by three curving lateral ridges, 1.43 m, 5.63 m, and 8.83 m from the bow (AU-CR Brno Mikulčice Reports, 1967). Like vessel II, the boat had a wide U-shaped cross-section sloping to V-shaped ends. A peg 6 cm in diameter and 12cm long with an asymmetrical head was found inserted through the hole in the bow platform (Klanica 1968:63). The vessel was conserved in PEG, and is on display in the Mikulčice National Cultural Monument museum with vessels I and II.

Vessels II and III were dated primarily by context to the first half of the tenth century, when river and flood sediment began filling the channels around the fortified islands. Poláček identified this context with the late Great Moravian period (Poláček 2000:206). Most wooden artifacts recovered from Mikulčice, including the dugout vessels, were found clustered in former river channels in and around bridges and the embankment wall. The artifacts are assumed to be associated either with construction or use of the bridges. Preliminary dendrochronology results date the causeway bridge to the last three quarters of the ninth century, providing an age estimate for the recovered items. Ceramic vessels and the assortment of iron axes and blades found in close proximity to the boats were "...safely dated to the eight and ninth centuries" (Klanica 1968:63). Logboat dating by dendrochronology was not possible due to an insufficient number of annual rings, while PEG conservation ruled out C14 dating of all but vessel IV.

Vessel IV.

The fourth and final logboat discovered at Mikulčice (inventory number 210/98) was uncovered during the 1984 excavations, nearly 30 years after the first finds. It was located some distance from the previous finds, in a former river channel near the third bridge. The vessel, measuring 6.72 m in length, was exceptionally fragile and in some places consisted of little more than an imprint in the soil (Poláček 2000:204). Despite the poor state of preservation, the vessel's form was, for the most part, visible. This boat appears similar to vessel II, with a pointed bow, two transverse ridges, and a rounded, overhanging stern platform. The cross-section was somewhat flatter than vessels II and III, with a more sharply hollowed-out stern. Due to its extremely delicate nature, it was decided that the vessel would not be raised and should remain *in situ*. After being documented and photographed, it was reburied. A hypothetical reconstruction was later drawn. Reconstructed dimensions are length 6.72 m, maximum width 75 cm, and height 26 cm (Poláček 2000:204). The two raised ridges are located 1.55 m and 5.52 m from the vessel's bow. This is the only Mikulčice vessel to be radiocarbon dated, revealing a construction date of 1180 +/-40 AD (Poláček 2000:206). This date is later than the settlement's main period of occupation, which occurred during the eighth and ninth centuries AD.

Related Finds at Mikulčice.

Three paddles were recovered from the Mikulčice excavations: two fragmentary and one in its entirety. The fragmentary specimens were carved from oak (*Quercus* sp.), while the complete example was maple (*Acer* sp.). The paddles were rather small with narrow, leaf-shaped blades (Figure 29).

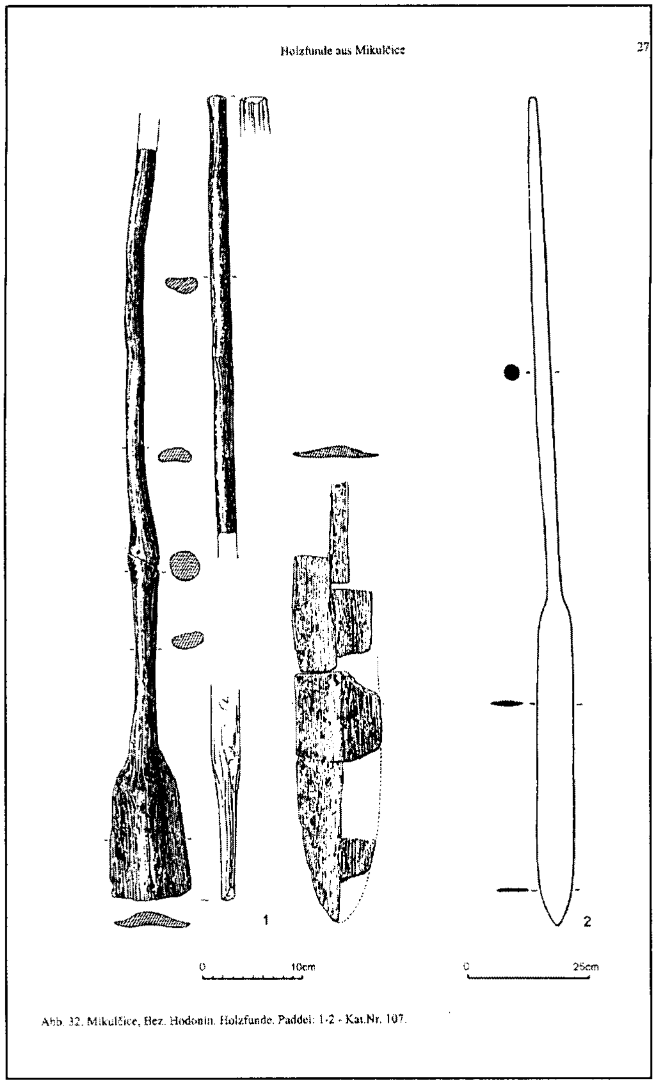


Figure 29. Mikulčice Paddles (Poláček 2000:271)

The paddle blades were 10 cm in width, and 70 cm in length. The handle length was approximately 100 cm, resulting in an overall length of approximately 170 cm (Poláček 2000:207). The fragmentary pieces were of similar size and shape.

Numerous fishhooks were recovered at Mikulčice, all but one made from iron (the exception being a single bronze hook) (Andreska 1975:133). One wooden spearhead for hunting fish was found. The spearhead had two barbed points, carved from an unspecified wood. The spear was 14.5 cm long, with a spread of 6 cm between the points (Andreska 1975:132). The excavations also uncovered at least 14 basketry fish-traps, woven from thin pliable willow branches (*Salix* sp.) (Poláček 2000:202). Several well-preserved examples show elongated arched necks and wide bodies. Based on ethnographic parallels, Andreska explained that the basket was placed in the water with the opening down; fish swam in from the bottom, and were unable to find their way out (Andreska 1975:135). The baskets, like the logboats, were located in the former riverbed, all but two amongst the piers and pilings of the main causeway bridge (Figure 30).

Andreska interpreted several perforated sandstone and ceramic objects as weights for fishing nets (Andreska 1975:135-136). Again from ethnographic analogy, Andreska suggested that nets were fastened to the shore by one end, and pulled out into the river by the other. Wooden floats were fastened to the net's top edge, the bottom edge was pulled down by the weights, and the net thus extended from the water's surface to the riverbed.

In this context, Andreska asserted that the Mikulčice logboats' main function was fishing, either with nets or spears (Andreska 1975:136).

Figure 30. Mikulčice Excavations, showing logboat (above), fish trap (below) (Poulík 1975:80)

Mohelnice.

A large and quite unique monoxyl logboat was found in the spring of 1999 near the northern Moravian town of Mohelnice. Dr. Jaroslav Peška, director of the Olomouc Archaeology Center and an avid angler, was fishing from a sandy beach of Mohelnice Lake when he noticed a strange log, partially buried in the lakeshore and protruding into the water (Jaroslav Peška 2003 pers. comm.). The log was unusual in that it had no branches or bark. After scraping away some mud and pushing his hand through a hole in the side, Dr. Peška ascertained that the log was hollowed out, tool marks were visible on the surface, and it was likely a dugout logboat.

Dr. Peška made many return trips to the site, but the vessel was too deeply buried in the lakeshore to be pulled out by hand. It was finally extracted using two large backhoe-type excavators, one on land and one in the water. There being no road to the site, large floats were attached to the vessel and it was pulled across the lake by a small barge. Finally it was lifted with a crane onto a flatbed truck, and transported to the Natural Sciences Museum in the city of Olomouc, some 35 km from the site. There was no place inside the museum large enough to house the vessel, so a special shed was constructed in the courtyard. The vessel was conserved for four years in low molecular-weight PEG, which was drained in the summer of 2003. High molecular-weight PEG is currently being applied to the surface with brushes.

The vessel measures 10.46 m in length, 1.05 m in width, and 50 cm high. There are four transverse ridges along the length of the boat, and neither bow nor stern is raised above the level of the gunwales. The stern has an unusual "duck-tail" that extends approximately 20 cm from the main body of the vessel. The bow tapers slightly in plan view, the stern not at all. The vessel is in very good state of preservation, with some damage to the stern, the point of the bow, and one hole resulting from damage or decay in the forward part of the boat. Samples were taken for speciation (*Quercus* sp.) and absolute dating (280 BC +/-75) (Jaroslav Peška 2003, pers. comm.).

Příkazy-Hynkov.

In September 1962, a monoxyl logboat was discovered in a meander of the river Morava at Hynkov. Local inhabitants pulled the vessel to the shore, and found a wide-bladed iron axe inside the boat. Investigators from the Institute of Natural Sciences in Olomouc concluded that the artifact, and therefore the vessel, was of medieval origin. (Trňáčková 1963; Hrala 1969). Both the vessel and the axe are stored at the Natural Sciences Museum in Olomouc (Helena Klanicová 2003, pers. comm.).

Rohatec.

Hrubý stated that in 1948 there was a report of a monoxyl find from the southern Moravian town of Rohatec (Hrubý 1965b:128). The bow of a vessel was said to be protruding from the bank of an arm of the Morava River, below the local chocolate factory. Hrubý wrote that a report was filed with the Archaeological Institute in Brno, but there is currently no such document in the Institute's archive. In the early 1970's, Dr. Zdeněk Klanica of the Czech Academy of Sciences, Institute of Archaeology in Brno heard rumors of this discovery and personally went to Rohatec to investigate, but found neither a vessel nor anyone who could confirm the story (Helena Klanicová 2003, pers. comm.).

Spytihněv.

On June 22, 1929, an oaken monoxyl was discovered below the fortress in the village of Spytihněv, in the Morava's bank (Hrubý 1965b:124). The boat lay buried in sand under an oak tree. The vessel's surface had a blackened appearance, and, aside from some damage to the bow and stern, was quite well preserved. It was 3.83 m in length, 60 cm in breadth at the widest point, and 30 cm high. Despite some distortion in the bow and stern, the boat's ends were slightly elevated in the vertical plane. The boat's interior was quite roughly hewn, leaving ripples or waves in the floor's surface. The vessel's noticeably shallow bow end was divided by a bulkhead carved from the solid and extending up to the level of the sides. The bulkhead thickened appreciably towards the boat's floor. 8 cm-wide shelves extended 47 cm from the bulkhead towards the stern, just below the top of the sides. Square depressions were carved into the shelves' stern ends to accept a seat-board or thwart. The boat was conserved in PEG in the early 1970's, and is currently on display in the Slovacké Museum in Staré Město (Luděk Galuška 2003, pers. comm.).

Staré Město.

In September 1946, during a period of extremely low water, a dugout logboat was found in the sandy bottom of the Morava river's main channel at Staré Město (Hrubý 1965b:127). One of the finders, Jaroslav Svoboda of Uherské Hradiště, described the vessel thus: "The boat's stern was sticking out of the sand in the direction of the current. After much pulling and tugging, a piece of the rear of the boat was broken off, about 150 cm in length. The rest of the boat was left buried in the riverbed. The old wood was completely blackened, and carved from the trunk of an oak tree. The hewing of the inside left a rippled corrugated surface. The sides were about 30 cm high, the floor was quite thick, and the width of the boat was about 60 cm. There was sort of tapering tail or platform at the raised stern end of the boat, cut out in the shape of the letter "T" (Hrubý 1965b:127) (Figure 31).

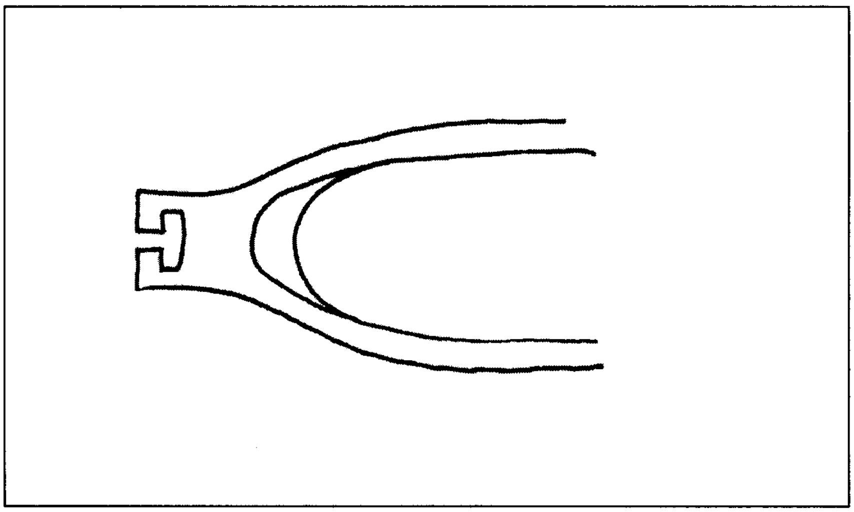


Figure 31. Staré Město Vessel Stern (after Hrubý 1965b:127)

The description of the stern cutout matches drawings from a vessel recovered in Bohemia, the 4 m Kolín vessel found in 1923 and described by Niederle (1923) (Figure 32). The boat's remains were left on the riverbank and, within a number of days, withered in the sun and fell to pieces. Dr. Hrubý could not ascertain the ultimate fate of these fragments (Hrubý 1965b:127).

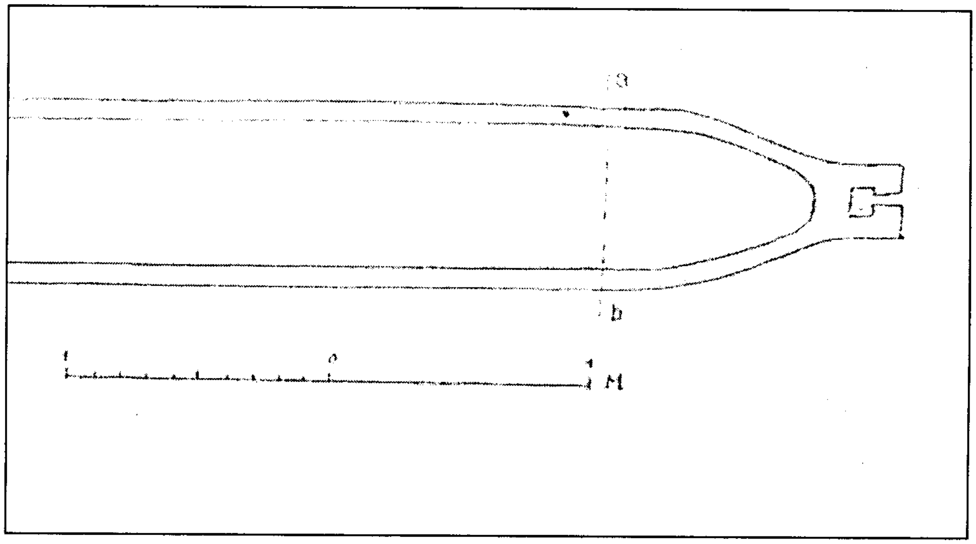


Figure 32. Kolín Vessel's Stern (Niederle 1923:34)

Uherské Hradiště.

On June 30, 1946, a dugout boat was found in the Morava river at Uherské Hradiště (Hrubý 1965b:126). The damaged vessel, carved from a single oak, was pulled from the muddy riverbed by members of the Uherské Hradiště rowing club. It measured 5.22 m in length, with a maximal breadth of 76 cm, and a height of 34 cm. The thickest point in the floor (13 cm) was at the vessel's middle, gradually thinning towards the bow and stern. The sides became quite thin, only 2 cm thick on their upper portions. The floor's maximum width was 52 cm, with a rounded transition to the sides. The bow and stern were raised above the level of the rest of the boat by about 11 cm. A tapering "block" was carved out of the solid wood floor near the bow, and two similar blocks were near the stern. There was an oval-shaped hole, 2.5 x 4 cm, cut in the bow. Witnesses stated that small pieces of bark still remained on the rounded bottom of the boat. The vessel's surface was completely blackened, and as it dried out it began to check and crack. At the time of recovery, a large part of the platform extending from the stern had already disintegrated. The boat was conserved in PEG in the early 1970's, and is currently on display in the Slovacké Museum in Staré Město (Luděk Galuška 2003, pers. comm.).

Veselí nad Moravou.

Workmen dredging and straightening the Morava river channel in 1928 came upon a large monoxyl near Veselí nad Moravou (Hrubý 1965b:124). The vessel lay beneath nearly 3 m of mud and sand, and stretched nearly from one side of the river to the other. Hrubý did not personally see the vessel, but witnesses stated that it was "about 20 paces" in length. This translates to a length of ca. 12.5 m, and if accurate, would make this vessel the largest found in Moravia (and indeed among the largest in Europe). Unfortunately, the vessel was completely destroyed by the dredging and excavation work, and no precise description is available.

The current chapter summarizes all known Moravian logboat finds. Chapter Six discusses potential methodologies for logboat analysis. Established analytical frameworks are discussed and compared. The author's reasons for choosing specific methodological and analytical techniques are presented. Data and features described in the current chapter are crucial for the analysis, results of which are presented in Chapter Seven.

CHAPTER 6: THEORETICAL AND METHODOLOGICAL CONSIDERATIONS

Methodology

As outlined in previous chapters, this thesis assumes that some aspects of logboat purpose, functionality, and intended use can be determined from a detailed typological and morphological vessel analysis. Prior to Seán McGrail's landmark work on the logboats of England and Wales (McGrail 1978), there existed no comprehensive terminology and quantitative methodology for analyzing artifacts of monoxylous dugout. Early logboat studies do exist, for example, Ferdinand Keller's work on Swiss lake villages (Keller 1865; 1878), Robert Munro's study of Scottish crannogs (1882), and Sir Cyril Fox's 1926 typology of English "dugout canoes" (1926). These early works essentially classified vessels by form, and then attempted analysis on that basis. While undoubtedly establishing a starting point for later research, early studies lack the sophistication of recent work on the topic. Commenting on previous logboat studies, McGrail stated that the "...assorted jumble of evidence may thus degenerate into the formulation of hypotheses based on inadequate foundations..." (McGrail 1997:103). In McGrail's opinion, real progress in understanding logboat form and function could be made only by *explicit quantification* during the analysis phase; he devised a number of indices for this purpose. Robert Mowat later used the system devised by McGrail, with some slight modification, in his analysis of Scottish logboats (Mowat 1996). Malcolm Fry's study of Northern Ireland logboats, while acknowledging McGrail's approach, used a somewhat different scheme (Fry 2000). All three systems are summarized below.

Seán McGrail, "Logboats of England and Wales"

As Dr. Seán McGrail's methodology is the first truly scientific system developed for analyzing logboat remains, it is worth describing in some detail. As stated by McGrail, his 1978 English and Welsh logboat investigation sought to interpret remains "...using techniques of wood science, naval architecture, and other scientific disciplines to deduce the function and operational capabilities of logboats," and to elucidate "...any patterns or regularities in time and space of form, structure, building techniques, or operational use..." (McGrail 1978:2). McGrail considered it absolutely essential to physically examine and record all existing and accessible vessels.

McGrail noted attributes such as timber species, method of converting the log, tool marks, and signs of former fittings or additions. Early conservation methods (or the lack of conservation altogether) resulted in severe distortion of many vessels. For most examples, current condition of the remains could be compared with drawings or measurements dating to the original exhumation, and any differences or changes taken into consideration during hypothetical reconstruction of the original vessel (or even whether such a reconstruction was possible). Comparative evidence, ethnographic, archaeological, or iconographic, was also used to deduce original hull-forms, construction, and usage (McGrail 1978:26-28).

Interpretation and analysis was conducted using selected calculated indices, drawing heavily on principles of naval engineering and architecture. McGrail's study examines theoretical issues such as the "ideal" logboat, aims of the designer/builder, which forms give desirable results, and how these choices affect logboat performance and safety. Performance is defined in terms of speed, payload, and maneuverability, while safety consists of structural strength and durability, watertightness, and stability (McGrail 1978:95). Logboat design, as with all watercraft, is a compromise between the creator's aims, the restrictions of raw material, and numerous variables at the air-water interface. Different shapes and features have different strengths and weaknesses. The rather technical details of McGrail's system can be found in Appendix A.

McGrail's calculated indices allowed him to make statements about individual vessels' function, form, propulsion and speed potential, and deadweight tonnage. The full range of information was available for only 24 vessels of 172 listed in his catalogue. McGrail stressed that the functional classification, based on such a small sample, provided only a relative assessment. A more final judgment of capabilities must wait until more logboats are available for comparison (McGrail 1978:329).

Robert J. C. Mowat, "The Logboats of Scotland"

In his study of Scottish logboats, Robert Mowat used a somewhat modified version of McGrail's methodology. Indices used by Mowat for ascertaining potential performance and function are as follows (Mowat 1996:5-6):

- Slenderness coefficient (indicator of speed potential)
- Beam/draft coefficient (indicator of type of cargo carried)
- Block coefficient (hydrodynamic efficiency indicator)
- Log conversion coefficient (construction efficiency indicator)

- Load space coefficient (payload volume indicator)
- Displacement volume (potential "swamping" indicator)
- Seaworthiness coefficient (ease or difficulty of capsizing indicator)
- Volumetric coefficient (indicator of speed potential)
- Midships coefficient (indicator of speed potential)
- Morphology codes: Canoe form, Punt/barge form, Dissimilar-ended form, Box form.

Mowat listed 154 vessels, of which 41 were still physically extant (at least in part). Interestingly, Scottish examples did not readily conform to McGrail's morphological categories; most should be classified as variants (Mowat 1996:124). Mowat provided relevant coefficients in each vessel description, but did not summarize functional vessel classification in his study. An interesting element of Mowat's study is his focus on environmental factors such as the availability of various timber species and the post-glacial vegetational history of Scotland (Mowat 1996:113). Also worthy of note is Mowat's discussion of finding logboat-related items such as paddles and oars, and similarly constructed items such as coffins, mill- and cooking-troughs, sledges and slides.

Malcolm Fry, "Coití: Logboats from Northern Ireland"

Malcolm Fry's study of Northern Ireland logboats, while acknowledging McGrail's pioneering work, utilized another analytical system entirely (Fry 2000:1). Fry deliberately omited the "complex hydrodynamic and architectural issues which other writers have handled exhaustively already" (Fry 2000:13). His analysis focused on "aspects arising from constructing and using dugouts…which will hopefully enable the reader to grasp the essentials of the manner in which ancient logboats were built and how they performed" (Fry 2000:13). Natural constraints of the raw material were particularly well covered.

The core of Fry's work, however, is based on empirical data gathered from construction and sea-trials of two modern experimental logboats. Data from trials of these vessels provided a number of benchmarks for establishing the draft and loading capacity of ancient dugouts (Fry 2000:28). The essential question regarding logboat function is "what did they carry, and how much?" Fry used what he calls "minimum freeboard theory," much as McGrail used his coefficients, to provide potential answers to these questions. Freeboard, expressed as a percentage of hull height at its lowest point amidships, is the single crucial variable. It is recommended that modern small craft maintain 40% minimum freeboard to preserve self-righting ability. Depending on the vessel's size, Fry assumed that ancient logboats could be taken as low as 30% minimum freeboard, or even lower. Fry's theory was tested against data obtained from the experimental vessels constructed in 1994 and 1995. Fry used a single formula for establishing safe loading capability, based on hull displacement and unladen draft (the "waterline footprint"):

[Load capacity in kg = [60% (or 70%) H'-D/H' x M] x [(L x B)/(L x B x H')],

where **D** is the unladen draft, **L** and **B** are hull length and breadth, **M** is hull mass, and **H'** is average height amidships. Hull displacement and draft are based on vessel mass and "waterline footprint," both of which can be estimated from scale drawings. This formula was tested against observed performance of the two 1995 experimental craft, and determined to be reasonably accurate (Fry 2000:30).

Data was sufficient for Fry to proceed with his analysis of 46 vessels of the 120 recorded in Northern Ireland. Fry concluded that most vessels were capable of carrying loads commensurate with their hull size, although several drew an unladen depth corresponding to around 40% freeboard. On one boat, the waterline reached the gunwales even without any applied load (Fry 2000:31).

Thesis Methodology

A documentary search was undertaken as a first step in identifying potential logboats from the Moravian region. Reports in the Czech Academy of Sciences, Institute of Archaeology, exist for several vessels in this thesis. There are considerable data published regarding all aspects of the Mikulčice excavations, including four logboats discovered there (see Poulík 1975; Klanica 1986; Poláček 2000). Further information was gained from a limited number of scholarly journal articles, and personal communication with Moravian archaeologists who worked with dugout vessels or on the excavations where they were found. The author was personally able to examine six surviving logboats (three from Mikulčice, and one each from Mohelnice, Spytihněv, and Uherské Hradiště) during a research trip in July 2003. Data from that visit form an invaluable part of this thesis. Field reports, notes, drawings, and maps from the Czech Academy of Sciences, Institute of Archaeology archives in Brno were likewise invaluable. Two other vessels survive, but were not accessible at the time of the author's visit. Criteria developed by Dr. Seán McGrail were used in judging what to record while inspecting vessels (McGrail 1978:24):

a) Record any feature that revealed something about the method of building the boat, its form, or its use.

b) Record anything that would document and quantify any changes in the boat's size and form.

Drawings are available for 9 of the 13 vessels analyzed here, although quality varies greatly. Very high quality drawings exist for the Mikulčice, Mohelnice, and Spytihněv vessels; others are rudimentary at best, and at least one (Kostelany), is totally conjectural. The material presented here is nonetheless the best available for all known Moravian logboat finds, and appears here for the first time in English. Vessel plans are presented in Appendix B.

For the analysis portion of this thesis, methodological elements from both McGrail and Fry are used. As Fry's system is considerably simpler than McGrail's, and is especially well-suited for vessel analysis based on scale drawings alone, the author has chosen to emulate many of Fry's methods. Essential definitions, theoretical background, and comparative material come from McGrail and other authors.

Specifically, this thesis uses Fry's system of gauging logboat draft from the vessel's mass and dimensions, and then calculating safe loading capabilities. As the relatively protected riverine environment of the Morava valley is unlikely to produce waves capable of swamping a boat, the author has chosen to use a 30% minimum freeboard requirement when making calculations. This methodology has the advantage of producing meaningful capacity estimates based on scale drawings. The drawback is readily apparent: the calculations are only as good as the drawings. Many measurements are combined to produce average areas and volumes. Better data are obtained from more accurate vessel plans, and the more measurements taken, the more accurate the results.

The specific steps followed, as developed by Fry, are outlined below:

1. Calculate hull mass by estimating exterior surface area, multiply by average thickness to produce volume. Multiply volume times specific density of green oak (1.09) to produce mass.
2. Incorporate mass into a formula relating it to the area dimension of the hull as it sits in the water (the "waterline footprint").
3. From the waterline footprint, calculate the unladen draft of the vessel. Once this is known, the amount by which the vessel can be further immersed, and thus the load-bearing potential, can also be calculated.

The Moravian logboats described in previous chapters will be analyzed according to the methodology presented above. The results of analysis are presented in Chapter Seven.

CHAPTER 7: ANALYSIS

Identification

Monoxyl boats are not the only artifacts constructed by hollowing out a log; there are many like-constructed objects, such as coffins, troughs, mill-chutes, and slips that may bear close similarities to logboats. McGrail proposed that a monoxylous dugout artifact be accepted as a logboat if it meets at least two of the following criteria (1978:19):

1. It is found in or near a (former) watercourse.
2. It is associated with other nautical artifacts, such as fishing tackle, anchors, paddles, and poles.
3. At least one end is shaped in one of the well-documented logboat forms.
4. It has (vestigial) fittings appropriate to logboats, such as thwarts, thole-pins, ribs, and stabilizers.
5. It measures more than about 3 m in length.
6. The bark and sapwood have been removed.

All vessels investigated in this study meet the above criteria, with the possible exception of the Rohatec find (which may have never existed). All vessels were found in or near watercourses, most in similar circumstances. Vessel morphology agrees with appropriate and documented forms, as do fittings and other features. Paddles and other nautical accessories were associated with at least one group of finds (the Mikulčice vessels).

Therefore, it may be safely assumed that the artifacts investigated in this thesis are dugout logboats.

Location, Spatial Distribution, and Circumstances of Discovery

There are hundreds of kilometers of navigable waters in Moravia, it is therefore interesting to note that the spatial distribution of logboat finds, regardless of chronology, is exclusively limited to the banks of a single watercourse: the Morava river. There is no natural or geographic obstacle to using watercraft on other Moravian rivers, for example the Svratka, Bečva, or Dyje. While it cannot be assumed that all buried monoxyls have been discovered, it is nonetheless peculiar that not a single vessel has been found on other rivers or in lakes. This distribution parallels that in Bohemia, where all dugout finds come either from the Elbe River, or short distances up its tributaries (Hrala 1969:816). A similar limited distribution is not recorded in other European regions, although Van de Noort noted that in Bronze Age Britain, logboats were used only for inland navigation, and sewn-plank vessels for seafaring (Van de Noort 2003:406).

The spatial extent of logboat finds in the Morava River valley from the southernmost (Mikulčice) to the northernmost (Mohelnice) is a linear distance of 110 km or approximately 135 river km (37% of the Morava's 362 km length from the headwaters to the Danube confluence) (Figure 33). Within the larger region, logboats remains are documented on the Váh River in Slovakia to the east (Novotný 1951), the Oder and Vistula rivers in Poland to the north (Ossowski 1999), the Elbe River in Bohemia to the west (Novotný 1951), and the German and Austrian alpine lakes to the south (Angerer 1927; Kunze 1968; Pflederer 2002).

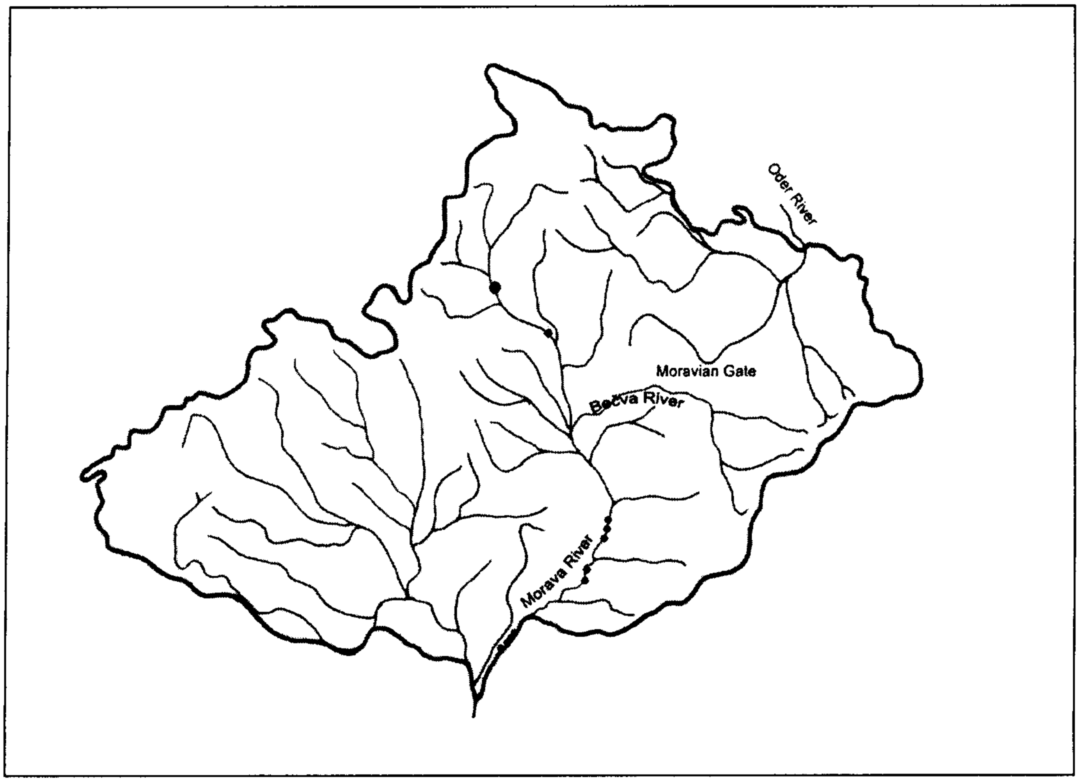


Figure 33. Spatial Extent of Moravian Logboat Sites (Jason Rogers:2004)

One reason for the frequency of finds in the Morava undoubtedly stems from the heavy modern use of this river, as well as straightening and deepening that began in the nineteenth century and was completed only in 1982. The dredging and deepening had a threefold purpose: to improve navigability, to provide water for irrigation purposes, and mitigate damage resulting from regular flooding. Of the 14 vessels examined in this study, four were discovered during excavation work in the river or its banks (Kostelany, Spytihněv, Staré Město, and Veselí nad Moravou). Unusually low water levels, which occurred in the Morava in 1922 and again in 1946, are specifically mentioned in reports on three vessels (Lideřovice, Staré Město, and Uherské Hradiště). Chance discoveries by people other than workmen account for three vessels (Mohelnice, Příkazy-Hynkov, and Uherské Hradiště). The only boats uncovered during the course of deliberate archaeological excavation are the Mikulčice vessels (although coincidentally, the chance discoverer of the Mohelnice vessel happened to be an accomplished archaeologist).

Vessels recovered from two locations (Mikulčice and Mohelnice) were assumed to be in "original" settlement or habitation sites (as opposed to those recovered from locations of secondary deposition, i.e. sunk in river channels or deposited by floodwaters). The Mikulčice settlement, dating to the eighth and ninth centuries AD, was located on islands connected to the mainland and each other by wooden causeways, and fortified with palisade walls and ramparts. The Mohelnice site has not yet been investigated in detail, although the discoverer, Dr. Jaroslav Peška, believes it to be a village built on poles and pilings, similar to Biskupin in Poland or Federsee in Germany (Jaroslav Peška 2003, pers. comm.). The Mohelnice vessel was recovered from a position between parallel rows of posts, and more posts and pilings are visible at various points around the lake. McGrail, (citing Beaudoin) described how a dugout could be secured to the bank at the bow, and held in position by a row of stakes (McGrail 1978:90). Similarly, two Irish Bronze Age logboats were found in "a prepared anchorage" between rows of poles set into the margin of Lough Neely (Fry 2000:22). Dugout vessels have been recovered from lake villages in nearly every region of Europe: Switzerland (Keller 1878), Germany (Paret 1930), Poland

(Rajewski 1959), Italy (Castiglione and Calegari 1987), and from the crannogs of Ireland (O'Sullivan 1998) and Scotland (Munro 1882; Mowat 1996).

Morphology: Hull Size and Shape

The complete and reconstructed Moravian vessels range in length from 3.83 m to 10.46 m, in breadth from 0.6 m to 1.05 m, and in height from 0.26 m to 0.5 m. Of the vessels investigated by McGrail, lengths ranged from 2.67 m to 16.15 m, with 50% within the range 2.77 m to 4.65 m. The broadest boat measured 1.52 m, with 67% of the vessels within the range 0.73 m to 0.99 m (McGrail 1978:325). Dimensions of complete Moravian vessels are listed in Table 1.

Table 1: Vessel Dimensions

Vessel	Length (cm)	Maximum beam (cm)	Height (cm)
Mikulčice 2	883	66	36
Mikulčice 3	988	71	45
Mikulčice 4	672	75	36
Mohelnice	1046	105	50
Spitihněv	383	60	30
Uherské Hradiště	522	76	34

Morphologically, the Mikulčice logboats bear close resemblances. Other vessels in this study are striking in their lack of similarities, exhibiting a remarkable range of features and constructional styles. One factor is chronological: the vessels span more than one thousand years. Other factors may be related to region and geography, with each locality or builder having particular features and styles.

Construction: Materials and Features

All identified Moravian vessels were fashioned from oak (*Quercus* sp.). As mentioned in Chapter 4, the majority of European logboats represented in the archaeological record are made from this wood. The predominance of this species as the building material for logboats in Bohemia and Moravia is such that the colloquial name for these vessels, "dubovky" ("oak-ers") is derived from the Czech word for oak (dub) (Novotný 1951:257).

There is evidence for transverse ridges, or ribs, on at least six vessels examined in this study (Kostelany, all four vessels from Mikulčice, and Mohelnice) (Figures 34, 35).

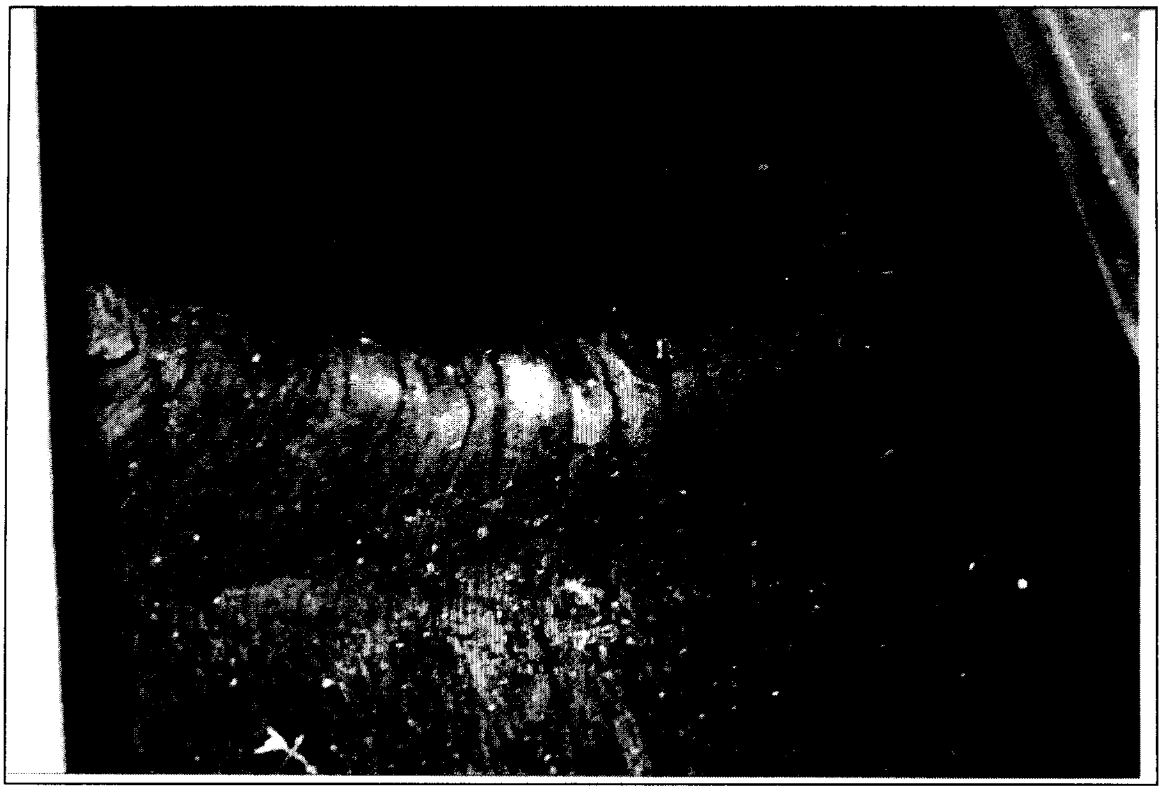


Figure 34. Transverse Ridge on Mohelnice Vessel – vessel width is approximately 1 m (Photograph: Jason Rogers, 2003)

Transverse ridges cut in the solid have been reported on dugout vessels from across Europe, and even from Asia (Hornell 1946:187) and the New World (Wheeler et al. 2003:540).

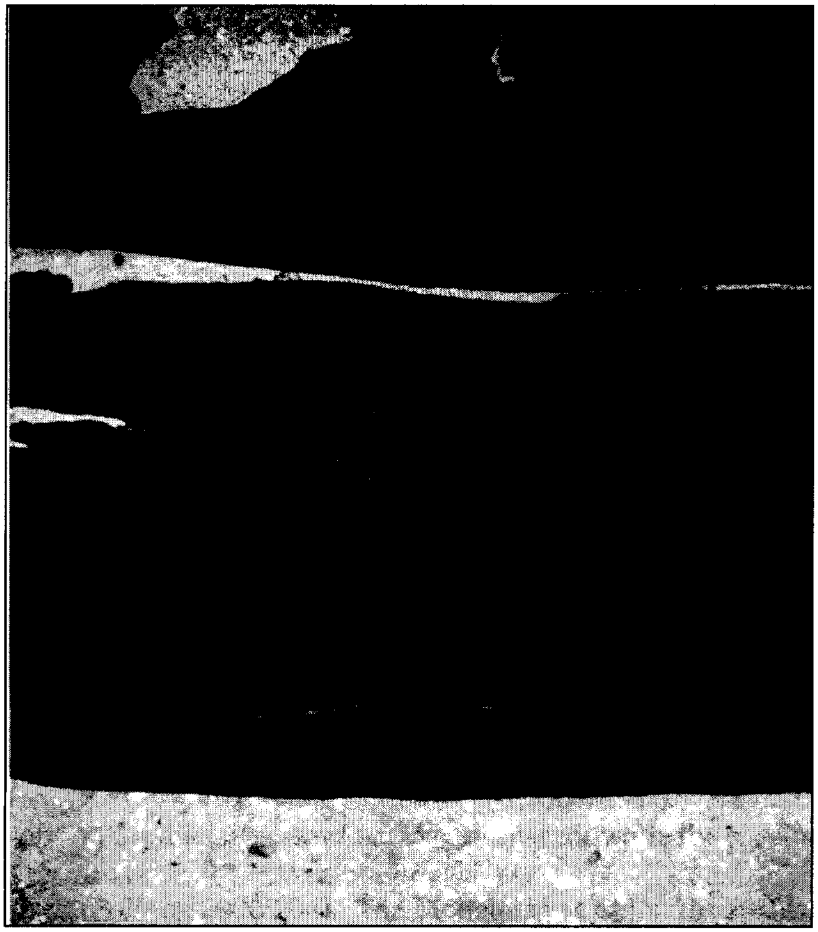


Figure 35. Transverse Ridge on Mikulčice II - vessel width is 66 cm (Photograph: Jason Rogers, 2003)

Early studies assumed that such ribs were intended to strengthen the vessel. Fox stated, "Interior projections – ribs – on the floor to give extra strength are frequently met with"

(Fox 1926:129), and Munro observed, "...some [dugouts] have cross bands, like ribs, left in the solid oak at regular intervals, as if to strengthen the sides of the vessel..." (Munro 1882:9). This view was propounded as late as the 1960's, for example, Nechvátal asserts that ribs "...obviously had the purpose of strengthening the sides of the vessel" (Nechvátal 1969:812). Clark, citing Paret and Hornell, convincingly argued, however, that transverse ribs or ridges, "...can hardly have reinforced the boat to any worthwhile extent, since they cross the grain of the wood" (Clark 1952:287). There is a range of alternate explanations: Hornell (1946:187) believed that ridges are skeuomorphic representations of boat frames; Clark (1952:287) suggested that they gave clearance to floor planks; and Beaudoin (1970:76-87) argued that they demarcate various types of functional space within a boat. McGrail tended towards the latter view, and noted that a ridge located near the stern of a vessel may have functioned as a footrest for a paddler sitting near the end (McGrail 1978:56). Hornell considered ribs carved in the solid to be a general chronological marker: vessels with ridges being older, while "...in the finest dugouts [of later date] these ridges have been suppressed" (Hornell 1946:187). Poláček noted that the ribs on Mikulčice vessel I are evenly spaced, while the spacing of those on vessel II is uneven (Poláček 2000:204). The Mohelnice vessel's ribs are also evenly spaced down the length of the vessel. Ridge spacing as a percentage of vessel length is shown in Table 2.

Table 2: Ridge spacing on Moravian dugout logboats

Vessel	Length (cm)	Ridge 1	Ridge 2	Ridge 3	Ridge 4
Mikulčice II	883	23%	63%	-	-
Mikulčice III	988	14%	57%	89%	-
Mikulčice IV	672	23%	82%	-	-
Mohelnice	1046	17%	31%	45%	82%
Spitihněv	383	39% (bulkhead)		-	-

The Uherské Hradiště boat, while lacking ribs, does have tapering floor blocks that may have been used as footrests. McGrail established experimentally that a 1.65 m paddler sitting at sheer level on the stern would extend his feet to a range of 20 cm to 55 cm, and exceptionally to 70 cm, from the edge of his seat (McGrail 1978:132). The floor blocks at the stern of the Uherské Hradiště vessel barely fit within this range, being located a horizontal distance of only 20 cm from the edge of the stern platform. In addition, the front rather than the rear edge of the blocks are cut with a taper, making a rather uncomfortable footrest. Finally, this theory does not explain the presence of a third block near the vessel's bow. The blocks' intended function thus remains rather mysterious.

At least two vessels, Lideřovice and Spytihněv, show evidence of thwarts or internal benches. The Lideřovice vessel had a bench carved from the solid located near the bow. Although no scale drawing exists, and the vessel itself was destroyed, it seems logical that the bench served a seating function.

The Spytihněv vessel, currently located in the Slovacké Museum in Staré Město, has ledges extending from a bulkhead along each side with depressions carved out to receive a seat board or thwarts (Figure 36). The bulkhead itself was likely used to divide the boat into different functional spaces (McGrail 1978:57). Morphologically, this is very similar to several late medieval Polish logboats described by Ossowski (1998:130-135). Unfortunately, radiocarbon dating of the Spytihněv vessel is no longer possible due to conservation in PEG.

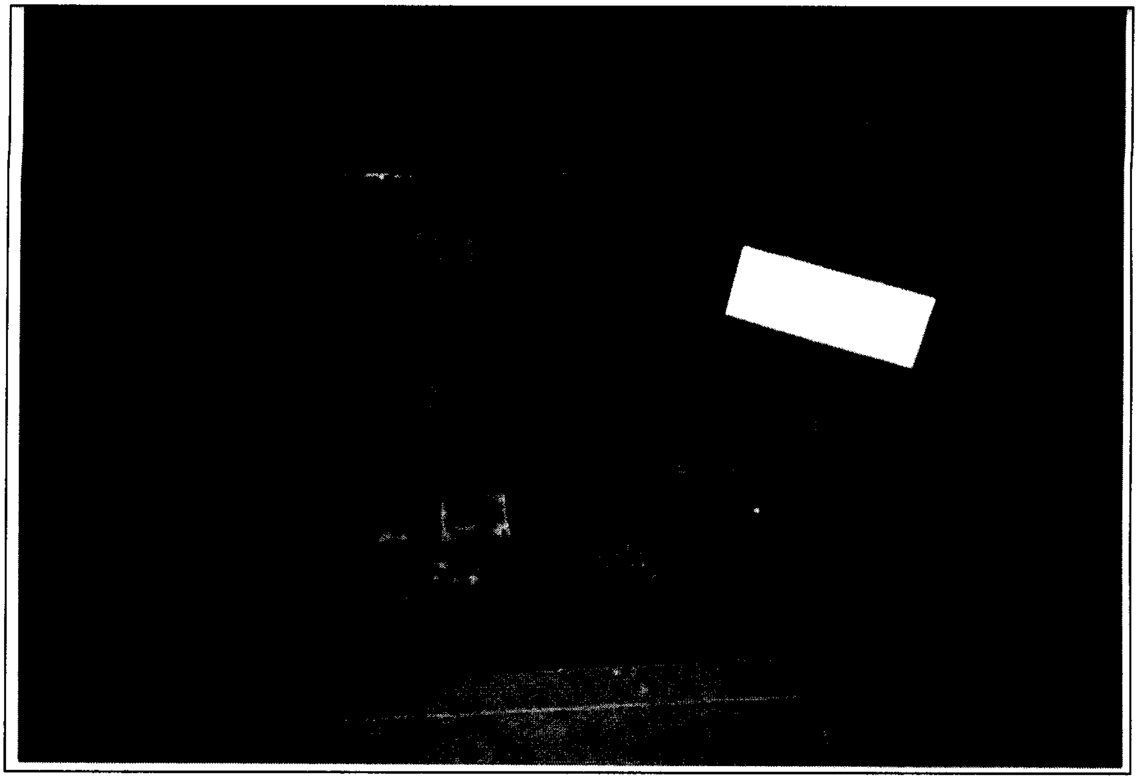


Figure 36. Spytihněv Vessel Thwart Fittings – vessel width is 60 cm (Photograph: Jason Rogers, 2003)

Platform ends are clearly apparent on two vessels (Mohelnice and Uherské Hradiště), and less so on two others (Mikulčice II and possibly Staré Město). Such platforms have generally been interpreted as seats (McGrail 1978:63). In the case of the Mohelnice and Uherské Hradiště vessels, the platform tail could also serve the purpose of improving sailing performance by smoothing the laminar flow as the boat moved through the water, as well as providing extra flotation and shielding crew from spray (Zubaly 1996). There is a structural advantage to be had as well; a dugout end shaped like a "duck-bill" (Figure 37) resists splitting and cracking caused by differential drying of wood fiber (McKee 1983:56).

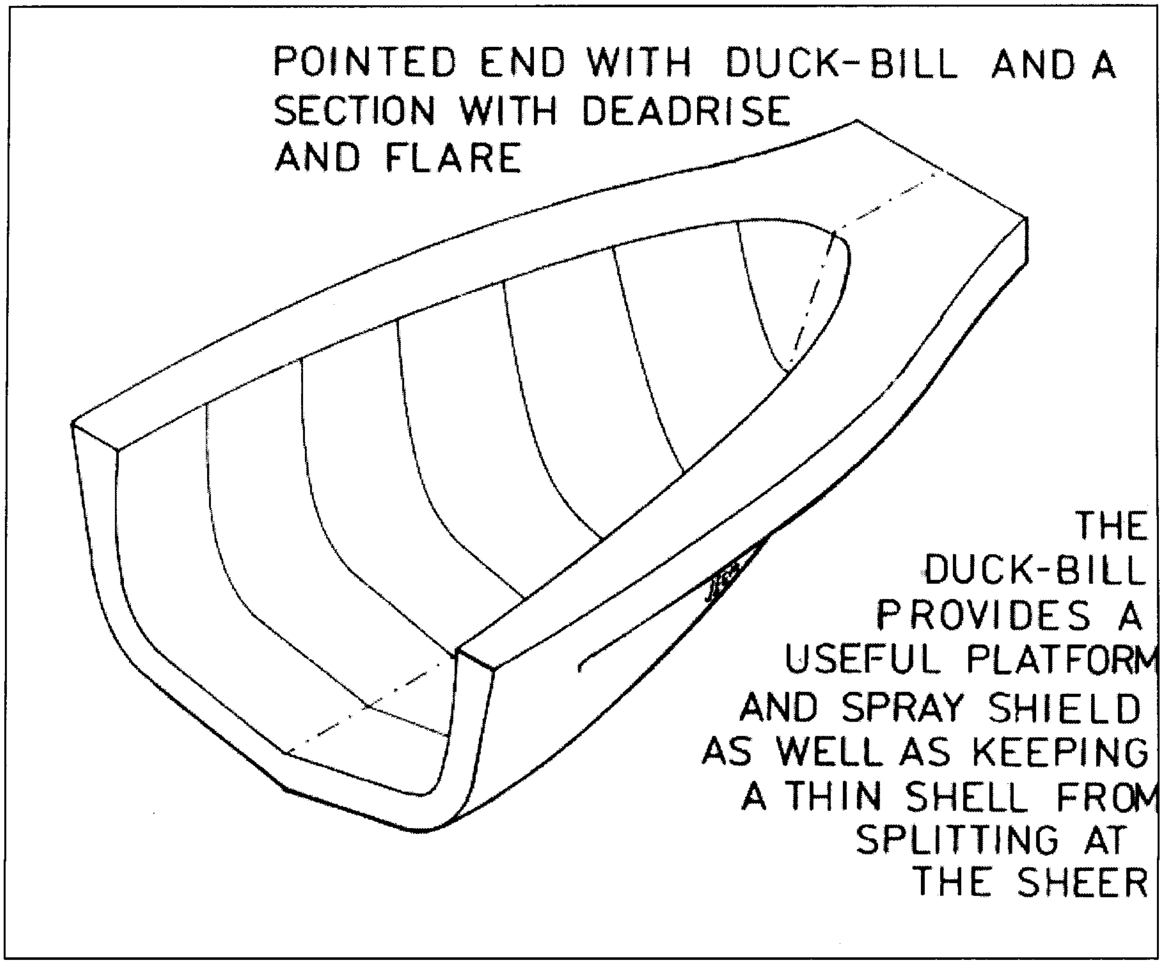


Figure 37. "Duck-bill" End (McKee 1983:56)

The bow ends of Mikulčice vessels II and III have square holes that vertically perforate the overhanging ends, and a peg was found inserted through the hole in vessel III (Figure 38). Poláček asserted that the peg was used to tie the boat for mooring (Poláček 2000:204). McGrail recorded the use of such holes for mooring poles, and also for towing the vessel (McGrail 1978:69,79). The tenth century Clapton logboat had a round hole 4 cm in diameter drilled vertically through one end, also interpreted as being used for a mooring or towing stake (Marsden 1989:95).

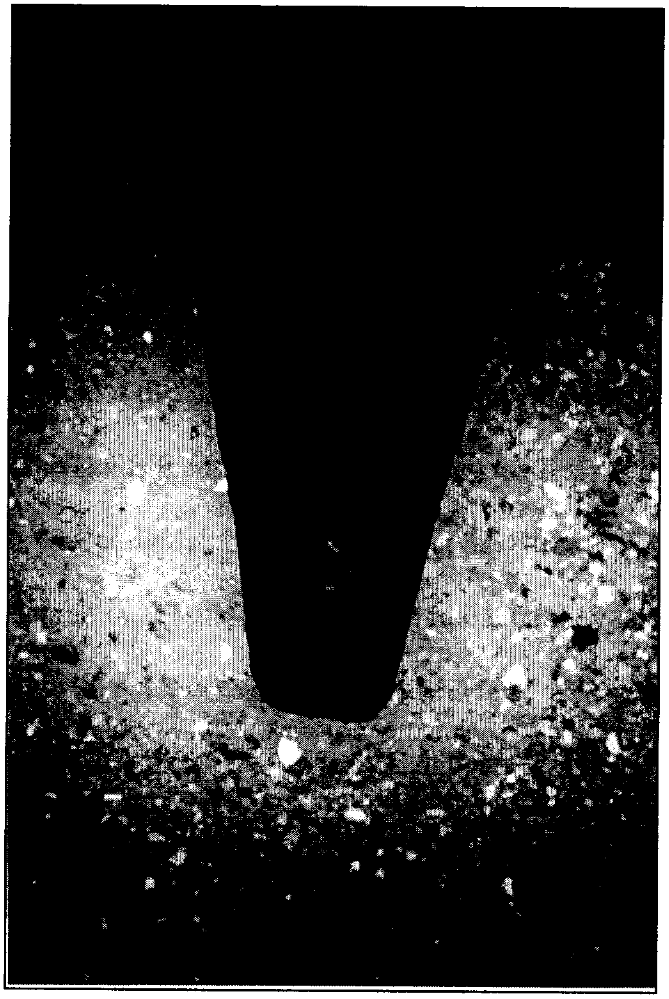


Figure 38. Mikulčice Vessel III Bow Peg (Photograph: Jason Rogers, 2003)

It is possible that the T-shaped cutout in the Staré Město vessel's stern was also used for mooring, although Niederle supposed that a rudder or steering paddle was inserted in a similar slot in the Kolín logboat (Niederle 1923:34). Hrubý reported that the Lideřovice boat had horizontal holes through the vessel walls on either side of the bow, unfortunately he did not record the size or diameter (Hrubý 1965b:124). McGrail offers several interpretations for such holes, generally explained as evidence for fittings for transverse members such as thwarts, projecting handles used for mooring, and rubbing strakes or spray deflectors (McGrail 1978:80).

To the author's knowledge, the metal bands that encircled the Kostelany vessel are unique. Nothing comparable is reported in any logboat literature. The only remotely similar features noted by other researchers are short metal straps or clamps sealing splits or holes (for example Mowat 1996:126; McGrail 1998:65). Such clamps are clearly repairs, while the function of the Kostelany bands remains unknown. As drawn and described by Hrubý, the bands' ends completely covered the tips of the vessel's bow and stern. In these areas, they potentially served to protect the wood from rubbing, collision or impact. Mowat recorded a vessel from Lea Shun in the Orkney Islands whose "bow had been strengthened with a 4.5 in. metal 'binder' which was recessed into the inner edge of the timber" (Mowat 1996:49). The Lea Shun boat, which had also been repaired with oak patches, was accidentally destroyed in the 1960s. Hrubý noted that the bands around the Kostelany vessel "encircled a round socket in the boat's side" (Hrubý 1965b:128). McGrail offered several interpretations for such holes, including fittings for washstrakes, thwarts, or as grommets for oar tholes or yokes (McGrail 1978:80). The metal bands' function around such a fitting is not clear.

One feature that is quite common on many European logboats is conspicuous by its absence on Moravian vessels. Thickness gauges, i.e. holes bored in the vessel's bottom from the outside of the log to the depth of the intended floor thickness, are found on logboats from the British Isles to Siberia (McGrail 1998:61). After hollowing the vessel's interior, the holes are then plugged with dowels or treenails. The author was unable to locate any evidence for depth gauges, either in descriptions or physical examination of the Moravian logboats. A lack of depth gauges may therefore be a feature specific to the Moravian dugout-building tradition.

Dating

As mentioned in previous chapters, dating for the Moravian vessels, as for logboats elsewhere, is difficult. Until very recently, logboat remains were simply assumed to be "ancient" or "prehistoric". Mikulčice vessels I-III were excavated from a reliably datable context; they are dated to the eighth and ninth centuries AD (Poláček 2000:206). Radiocarbon dating exists for only two vessels: the Mohelnice boat was dated to 286 BC (Jaroslav Peška 2003, pers. comm.), and Mikulčice IV was dated to 1180 +/-40 (Poláček 2000:206). Dating data for the Moravian vessels are sparse in comparison with broader regional research: in Poland, for example, Ossowski has compiled a catalogue of over 300 dugout vessels, 132 of which have been dendrochronologically or radiocarbon dated (Ossowski 1999:212).

The context and dating for the Mikulčice vessels correspond to the Great Moravian period (eighth – tenth centuries AD). The settlement at Mikulčice is the largest and richest site known from this period. The other large Great Moravian stronghold was located on the Morava River by the modern cities of Staré Město and Uherské Hradiště. Six vessels were found along the Morava within 20 km of this settlement, including one each in Staré Město and Uherské Hradiště.

The radiocarbon date for the Mohelnice vessel corresponds to the La Tène B2 culture in Central Europe identified with the Celtic Iron Age (Drda and Rybová 1998:9). Evidence of contemporaneous Celtic settlement in Moravia consists of more than 300 investigated sites such as the agricultural village at Bořitov, and the fortified *oppida* at Staré Hradisko and Hostýn along the Moravian Gate amber route (Čižmářová et al. 1996:76; Čižmář 2002:38). While the advantages of waterborne trade and transport along the Morava River are clear in this context, it is interesting that the Mohelnice site is located nearly 50 km upriver from the Bečva confluence, the easiest route over the Moravian Gate.

Freeboard and Carrying Capacities

Measurements or scale drawings sufficient for purposes of analysis exist for 6 of the 13 vessels in this study. Calculations for these vessels are summarized below:

Mikulčice II:

Estimated Hull Mass = 519 kg, Q = 10.69, Unladen Draft = 16 cm, 563 kg loads the vessel to 30% freeboard.

Mikulčice III:

Estimated Hull Mass = 656 kg, Q = 11.36, Unladen Draft = 17 cm, 635 kg loads the vessel to 30% freeboard.

Mikulčice IV:

Estimated Hull Mass = 424 kg, Q = 10.1, Unladen Draft = 14.5 cm, 492 kg loads the vessel to 30% freeboard.

Mohelnice:

Estimated Hull Mass = 1024 kg, Q = 11.43, Unladen Draft = 17.5 cm, 1077 kg loads the vessel to 30% freeboard.

Spytihněv:

Estimated Hull Mass = 259 kg, Q = 12.5, Unladen Draft = 19 cm, 221 kg loads the vessel to 30% freeboard.

Uherské Hradiště:

Estimated Hull Mass = 262 kg, Q = 10.6, Unladen Draft = 16 cm, 285 kg loads the vessel to 30% freeboard.

Analysis results are presented in Table 3. The graph developed by Fry to determine unladen draft is presented in Figure 39 (2000:31).

Table 3: Moravian logboat carrying capacities

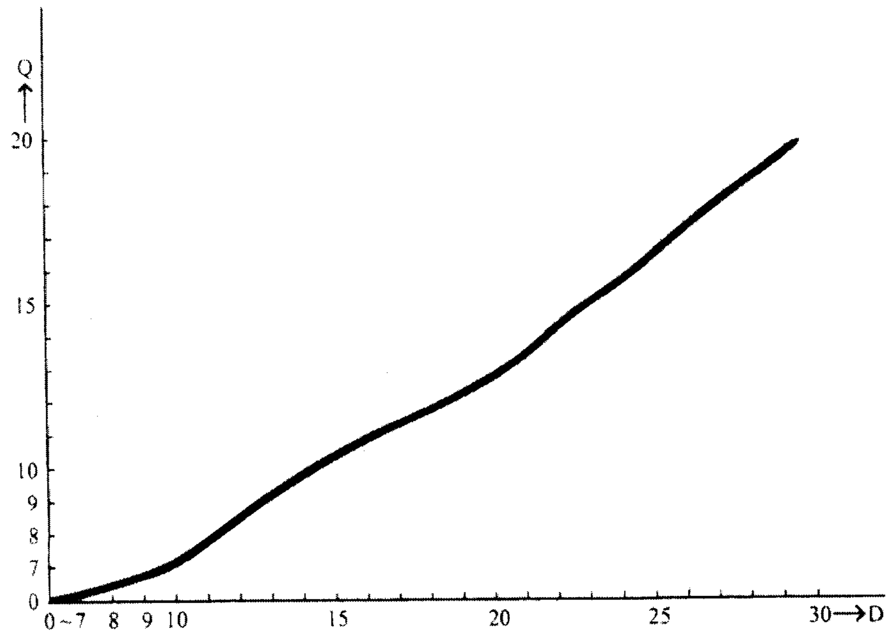
Vessel	L/B ratio	Estimated Mass (kg)	Unladen draft (cm)	Capacity at 30% minimum freeboard (kg)
Mikulčice II	1:13	519	16	563
Mikulčice III	1:14	656	17	635
Mikulčice IV	1:9	424	14.5	492
Mohelnice	1:10	1094	17.5	1077
Spitihněv	1:6	259	19	221
Uherské Hradiště	1:7	262	16	285

McGrail assumed that a prehistoric individual's average weight was 60 kg (1978:132). Using this figure, we can calculate the Moravian vessels' crew capacities (Table 4).

Table 4: Moravian logboat crew capacities

Vessel	Maximum Crew
Mikulčice II	9
Mikulčice III	10
Mikulčice IV	8
Mohelnice	18
Spitihněv	3
Uherské Hradiště	4

TABLE 1. Graph for calculating the approximate unladen draught of a dugout boat.



Q axis represents quotients obtained from formula

$$\sqrt{\frac{M}{\mathbf{L} \times \mathbf{B}}} = \mathbf{Q}$$

D axis represents suggested values in centimetres for quotients.

(For symbols refer to page 29, above.)

Figure 39. Draft Calculation Graph (Fry 2000:31)

Some simple conclusions can be drawn from these calculations. The vessels' physical dimensions make it unlikely that they were actually intended to carry the theoretically possible maximum crew. Reducing the Mohelnice vessel's crew to five people, weighing a combined total of 300 kg, allows capacity for 777 kg of cargo. The smallest vessel, (Spytihněv), could be easily paddled by a single individual and still carry a load of 161 kg. The 30% freeboard is an arbitrary "safe" loading level; given the desire or need the vessels could be loaded even heavier. The Moravian logboat builders, of all eras, clearly designed these vessels to transport cargo as well as people. Smaller boats could be used for fishing, local transportation, and high-value low weight payloads. The larger vessels, less maneuverable but capable of carrying tremendous loads, transported heavy bulk cargos.

Almost from the beginning of human history, the Moravian Gate was a highly trafficked corridor for movement between Northern and Southern Europe. Archaeological evidence and historical documents all demonstrate the critical importance of Moravian watercraft. River vessels fulfilled a vital transportation role, especially for moving bulky and heavy cargoes. Logboats were no exception; on the contrary, for several millennia dugout vessels were the main (if not only) craft used for navigation on the Morava River.

CHAPTER 8: CONCLUSION

The Moravian logboats are only a small piece of the larger puzzle of early European boat building and navigation. When compared to examples from around Europe, the Moravian vessels exhibit many similarities, as well as some remarkable differences. Cargo capacities are, in general, somewhat higher than those calculated by Fry for Northern Irish vessels. Morphologically, the Moravian boats match many forms recorded elsewhere. Features such as transverse ridges, thwarts, and mooring holes are similar to those on vessels from other regions of Europe. The most striking difference is a lack of depth gauges on Moravian vessels. The metal strips encircling the Kostelany vessel may also be unique.

This study found evident spatial distribution patterns. Major concentrations of dugout vessels appear between Spitihněv and Mikulčice, centered around Uherské Hradiště. This region contains the richest soils in Moravia, encouraging settlement and habitation. This study found no distinct pattern of Moravian logboats' technical progress, however. In fact, the oldest dated vessel (Mohelnice) is also the largest and in many ways the most technologically advanced.

The chronological range for reliably dated specimens (third century BC to twelfth century AD) spans fifteen hundred years. Combined with ethnographic information, the data reveal a striking continuity of vernacular watercraft construction and dugout logboats in use on regional waters, from prehistory to the twentieth century.

Geographic conditions specific to Moravia provide environmental context for the vessels investigated in this thesis. The Moravian Gate, used as one of Europe's main north-south corridors virtually since the beginning of human history, is the central landscape feature considered in analysis. Archaeological and historical evidence demonstrate the Morava River's central role in the lives of regional inhabitants, both prehistoric and modern. Utilization and exchange of key materials, especially amber, copper, salt, and bronze dominated the region's early commercial life. Later commodities included lumber and fish. Moravian watercraft purpose and usage must be seen in the context of resource exploitation and exchange. The dugout logboats found along the Morava River were essential vehicles for long-distance trade, travel, and communications.

Logboats recovered from specific sites reveal considerable detail. The great significance of the Mikulčice vessels, as indicated by Poláček, lies not only in their relatively good dating and preservation, but in their functional connection to the nearby settlement: "The boats are valuable evidence of early river navigation, which must have played an important role in the great Moravian centers such as Mikulčice" (Poláček 2000:207). All three major Great Moravian centers (eighth to tenth centuries AD) – Mikulčice, Staré Město, and Nítra – were located on river islands. Watercraft such as the Mikulčice vessels, capable of transporting bulky and heavy cargo, were essential for such traders to reach Moravian markets. The settlements' topography and placement was therefore not only defensive, but also motivated by important economic elements of trade and revenue.

The various fishing-related articles discovered at Mikulčice also reveal the riverine environment's significance as a food source to the Morava valley's inhabitants. Even in historic times, the lower Morava from Uherské Hradiště past the confluence with the Dyje was regarded as one of the richest fishing areas in the Czech lands (Andreska 1975:132). Thus, the river was not only the main artery of transport and communication, but also a main source of sustenance and nourishment.

Cultural components of the site-formation process are demonstrated in the case of the Mikulčice I vessel, which was apparently incorporated into the palisade wall fortification following the expiration of its use as a watercraft. This is an early example of a phenomenon known as redaptive reuse, observed from prehistory to modern times. McGrail reported medieval remains of reused boat timbers used to embank rivers and shore up waterfronts (McGrail 2001:431). As late as the nineteenth and early twentieth centuries, old or abandoned vessels were sunk in urban waterfronts for the purpose of shoring up wharves or extending docks. Much of San Francisco's waterfront, for example, was built on vessels abandoned there during the 1849 California Gold Rush.

Riverine communities devoted considerable effort and energy to logboat construction, over time building a body of inherited knowledge. Traditions developed as boat-builders honed skills and abilities. The time spent in constructing dugout vessels was repaid as they were used to exploit local resources and accumulate wealth from long-distance trade.

The results of analysis demonstrate the often surprising cargo-carrying capacity of even a small dugout logboat. Average vessels carried anywhere from 300 to 500 kg, greater ones more than 1000 kg. In a wider European context, even larger capacity vessels are known: McGrail calculated that the Hasholme logboat, for example, could carry over five tons of cargo in addition to five crewmembers (McGrail 1988:45). These capacities go far beyond the needs of passenger transportation. The larger vessels investigated in this study were clearly intended to play an important hauling role, especially for moving bulky and heavy cargoes.

The data, description, history, and analysis presented in this thesis fill a gap in our knowledge of European dugout logboats. In answering questions, however, new ones inexorably come forth. The basic questions addressed in this thesis provide a baseline for future work. Much research remains to be done. Cultural site formation processes are clearly at work, and should be further explored. Detailed investigations should be undertaken regarding the Moravian vessels' site contexts and deposition circumstances.

Logboats are popularly perceived as crude and primitive vessels, suitable only for minimal subsistence fishing or perhaps a trip across the river. This study suggests otherwise – logboats can be complex and sophisticated watercraft, designed with forethought and functional in roles reaching far beyond a simple fishing trip. For several millennia, Moravian logboats were an essential part of the great trade and exchange networks connecting Europe's northern and southern continental margins.

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Appendix A: Logboat Performance Indices devised by Seán McGrail (McGrail 1978).

To describe general logboat morphology, McGrail defined a number of hull-form types, grouped for convenience in four broad categories (McGrail 1978:130):

1. Canoe form: rounded ends in all three planes; a tapered body, with a rounded transverse section.
2. Punt or Barge form: ends rectangular in plan and inclined in elevation; a parallel-sided body, with a rectangular or flared transverse section.
3. Dissimilar-ends form: rectangular or transom stern in plan and elevation; a rounded bow in all three planes; a tapered body with a rectangular or rounded transverse section.
4. Box form: all elements rectangular in all three planes.

Vessels deviating from these basic categories are classified as variants.

In a two-part process, McGrail then carried out extensive calculations to establish theoretical hull-form performance. The analysis was based on five specific parameters: specific density of wood; number of crew; bulk density for three types of cargo (stone, wheat-grain, and turf); standard and minimum freeboard; and the vessel's hydrostatic properties (displacement, center of buoyancy, and transverse metacenter, which all vary with draft) (McGrail 1978:131-134).

Having established these theoretical parameters for each vessel, McGrail used the results to define indices for the purpose of evaluating logboats' potential performance and uses (McGrail 1978:136-140). Coefficients were calculated for four different operational states, summarized here:

A- Maximum men: the theoretical maximum number of paddlers which can be physically fitted into the boat.

B- Restricted draft: the theoretical maximum number of paddlers, plus that equipment or ballast which can be carried at a draft of 0.30m.

C- Standard freeboard: Minimum crew and maximum cargo which could be carried at a draft equivalent to a standard freeboard of 0.15m

D- Minimum freeboard: With crew as in (C), and maximum cargo which can be carried at a draft equivalent to the calculated minimum freeboard.

Coefficients for State A:

- Crew capacity coefficient: equal to maximum number of men carried/theoretical maximum (=M/Mx). Logboats with the maximum value of 1 can carry all the men there is room for.
- Manpower coefficient: equal to maximum number of men carried/displacement volume in m3 (=M/v). Logboats with higher coefficient values make best use of their displacement to carry men.

Coefficients for State B:

- Restricted draft crew coefficient: equal to deadweight/volume of log (=Wdwt/V1). The numerator is the weight of crew and equipment. The parent logs of logboats with higher coefficient values have been converted to efficiently operate in water not deeper than 0.30m.

Coefficients for State C:

- Critical bulk density: that density of cargo which results in zero metacentric height (GMt=0). Logboats with a low value are able to carry cargoes of widely different bulk densities.
- Deadweight coefficient: equal to deadweight/displacement in kg (=Wdwt/Δ). Vessels with higher coefficient values have been built so that they make best use of their displacement to carry high-density loads.
- Midships coefficient: equal to transverse section area/beam x draft in m2 (=Ax/BxT). The maximum value is 1, faster ships generally having lower values.
- Block coefficient: equal to displacement/breadth x length x draft in m3 (=Δ/BxLxT). Faster ships generally have low values.
- Slenderness coefficient: equal to length/beam in m (=L/B). Vessels with high values are long and thin in plan; they will generally be more difficult to turn but easier in holding a course. Higher values generally indicate greater speed potential.
- Length/draft coefficient: equal to length/draft in m (=L/T). Vessels with higher values are generally more maneuverable.

Coefficients for State D:

- High-density cargo coefficient: equal to deadweight kg/volume of log m3 (=Wdwt/V1). This coefficient is taken as an indicator of a vessel's ability to carry cargo at maximum draft.

Coefficients not dependent on operational state:

- Log conversion coefficient: equal to volume of timber in boat/volume of log in m3 (=Vt/V1). This is a measure of the work done in converting the parent log into a logboat. Vessels with a low value have had more timber worked away.
- Load space coefficient: equal to internal volume/volume of log in m3 (=Vh/V1). This is a measure of the efficiency in converting the parent log into a space to hold cargo or men. Logboats with high coefficients have proportionally greater space for loads.

Appendix B: Vessel Plans

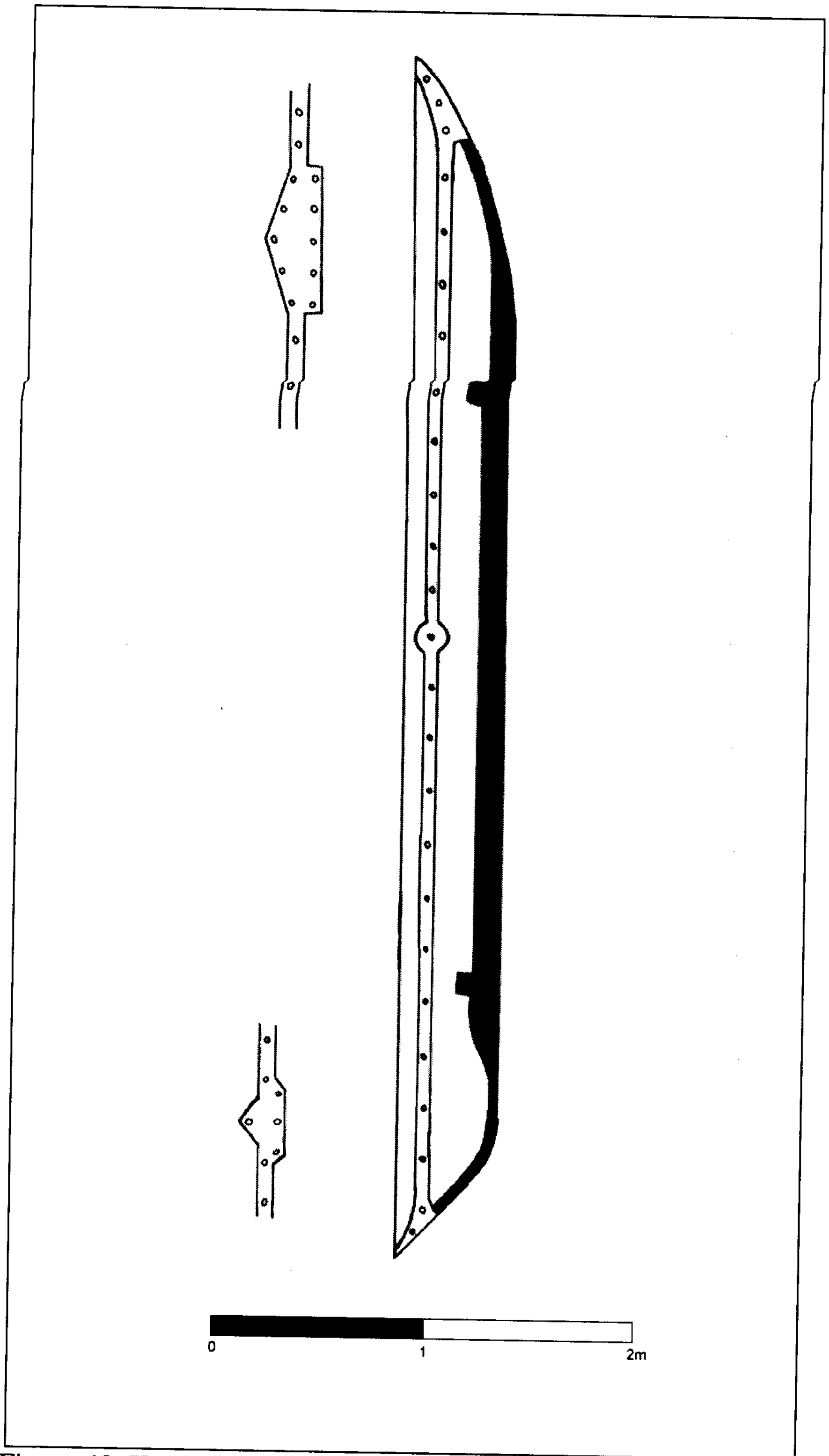

Figure 40. Kostelany Vessel (conjectural) (after Hrubý 1965b:128)

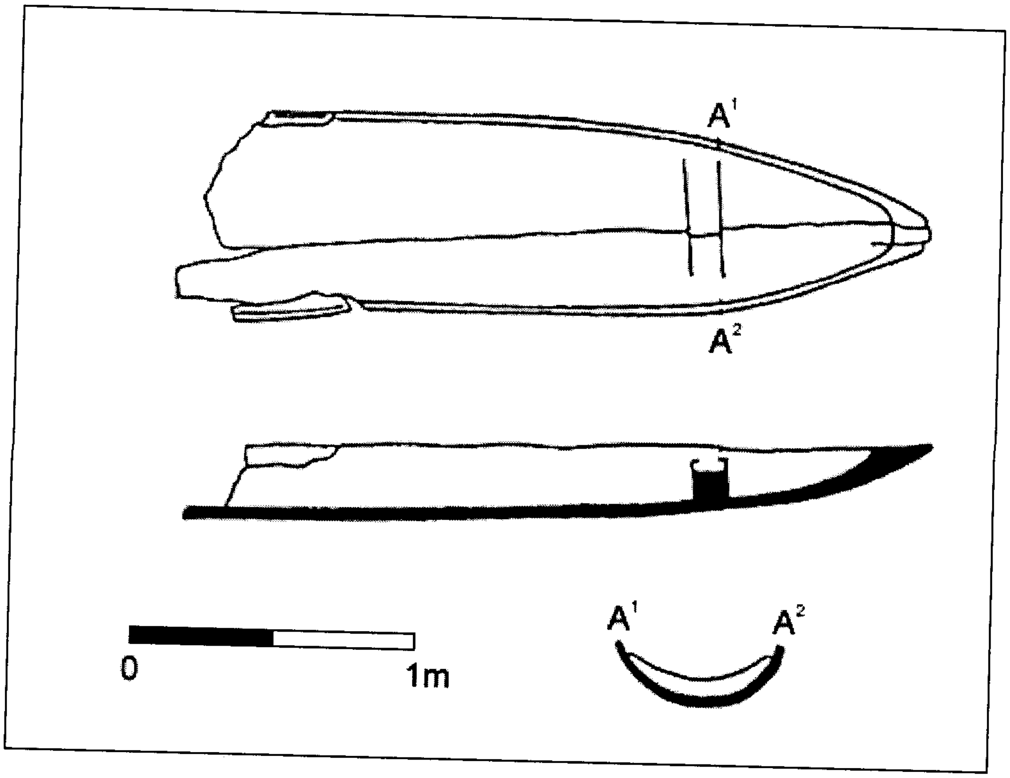

Figure 41. Mikulčice Vessel I (Bow Fragment) (after Poláček 2000:220)

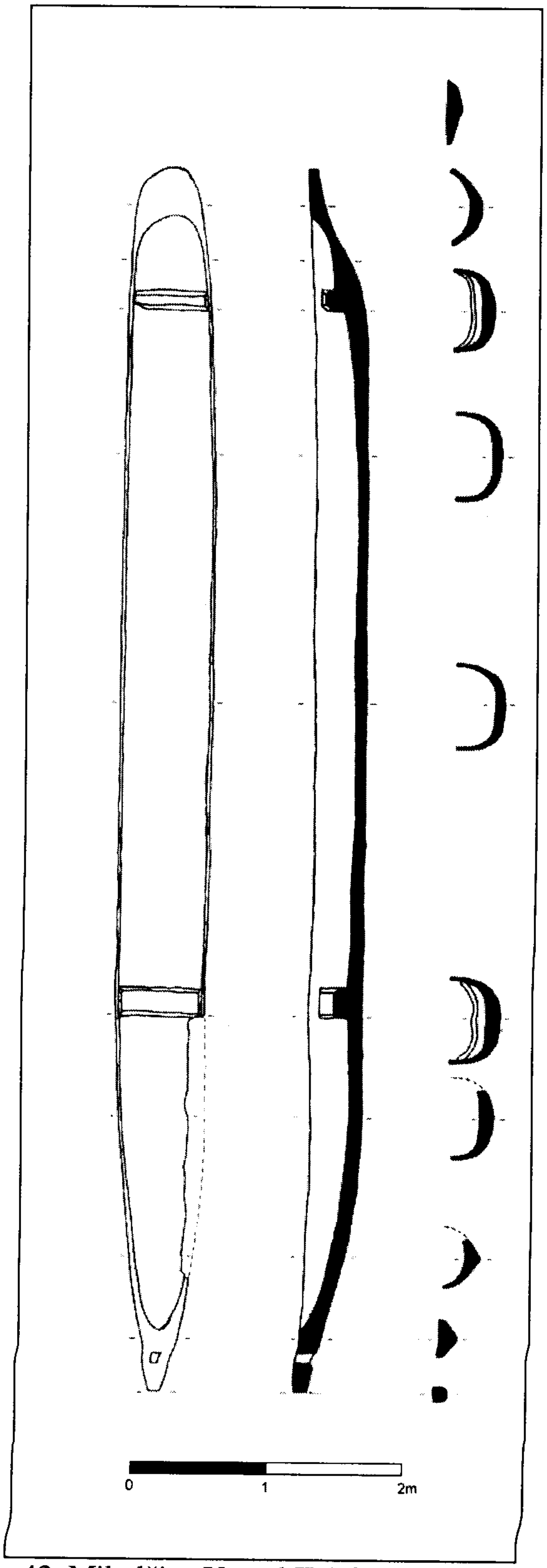

Figure 42. *Mikulčice Vessel II (after Poláček 2000:269)*

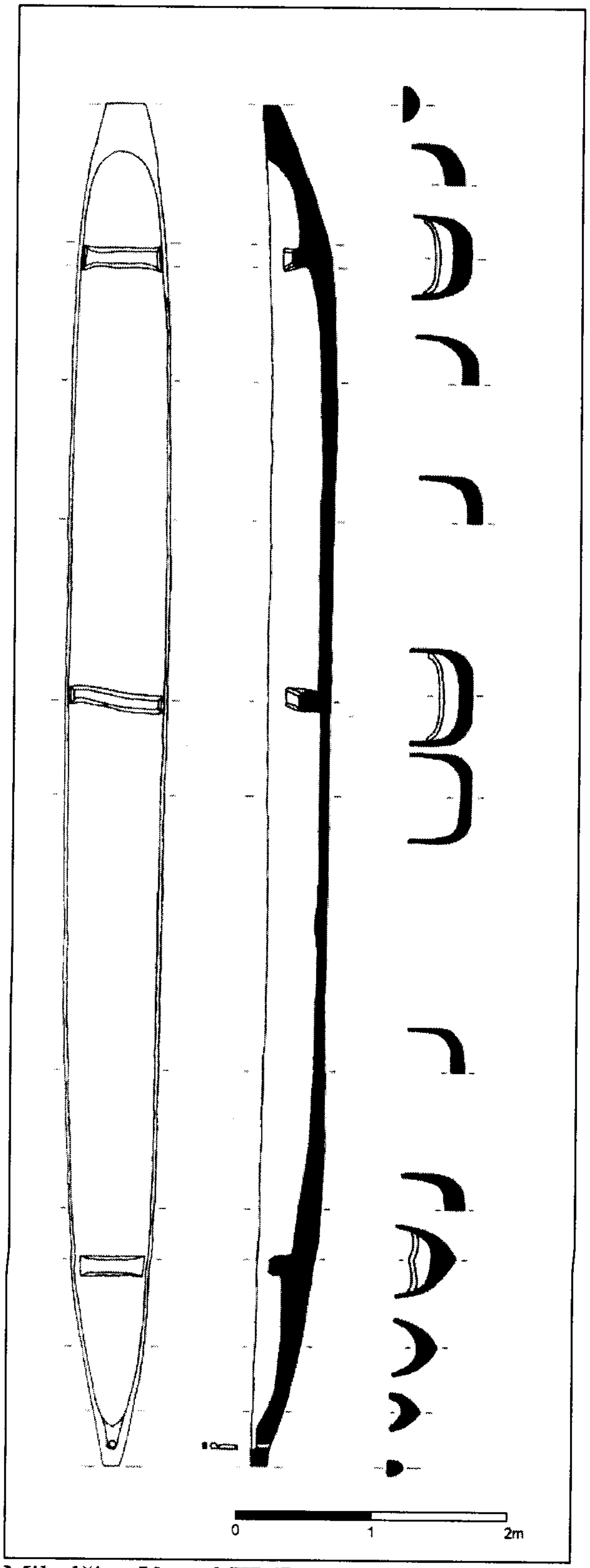

Figure 43. Mikulčice Vessel III (Jason Rogers after Poláček 2000:269)

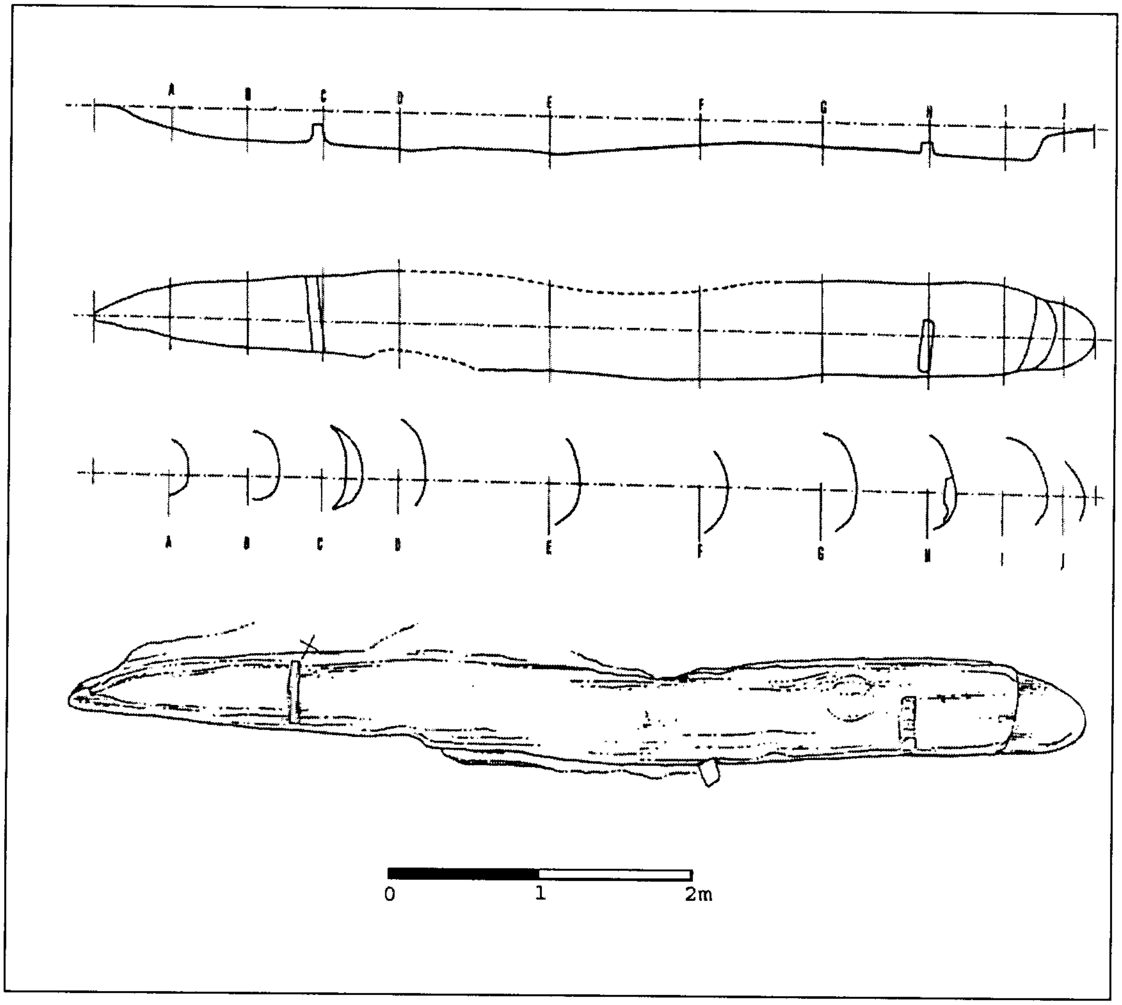

Figure 44. Mikulčice Vessel IV (Poláček 2000:268)

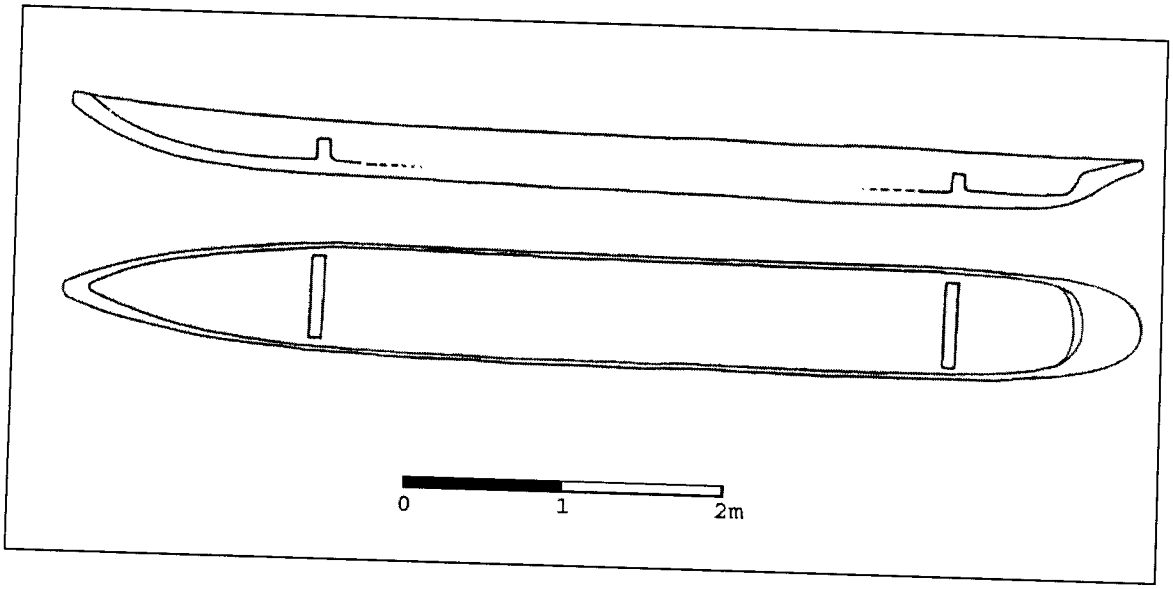

Figure 45. Mikulčice Vessel IV Reconstruction (Poláček 2000:268)

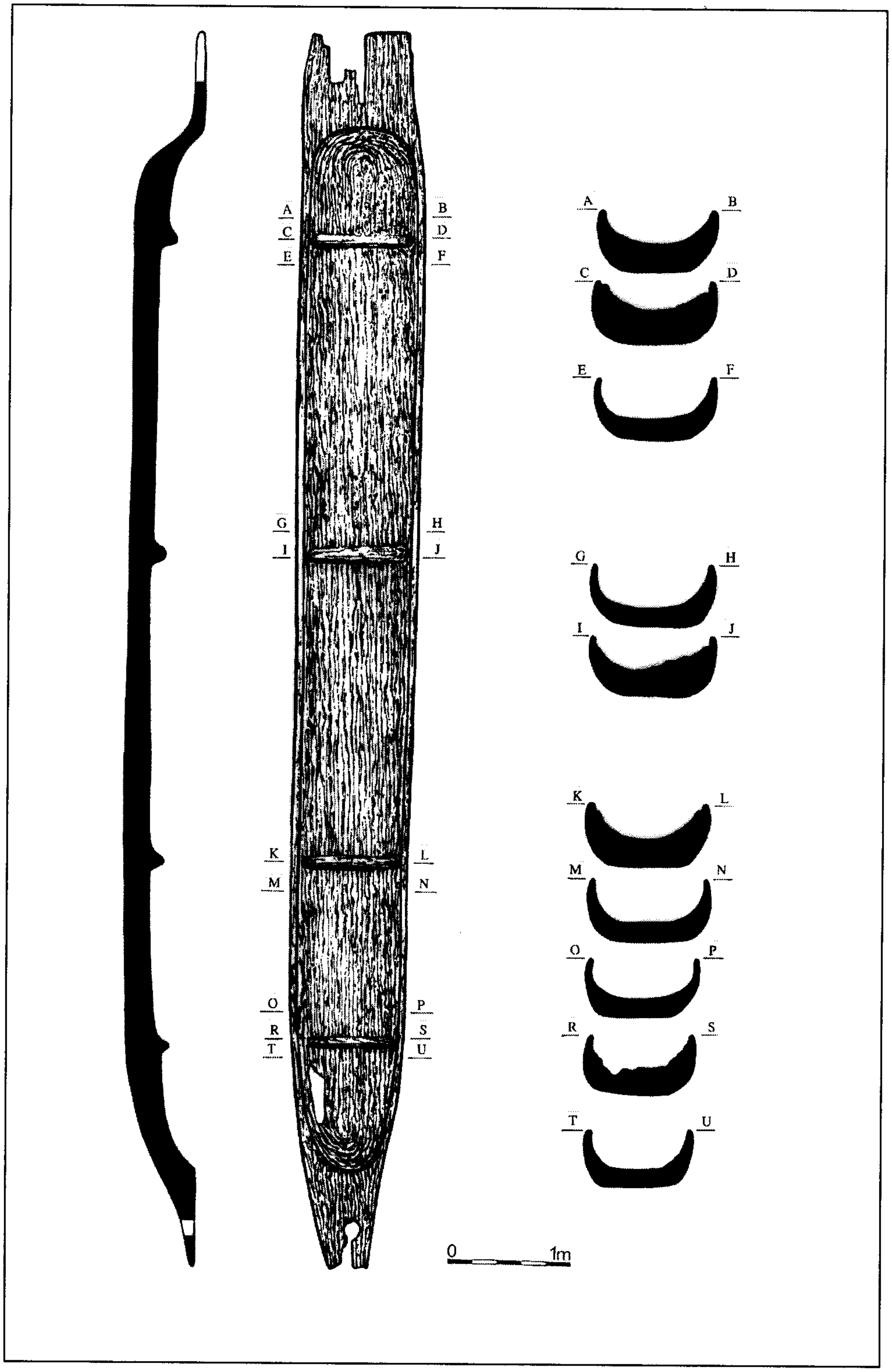

Figure 46. Mohelnice Vessel (Jaroslav Peška 2004, elec. comm.)

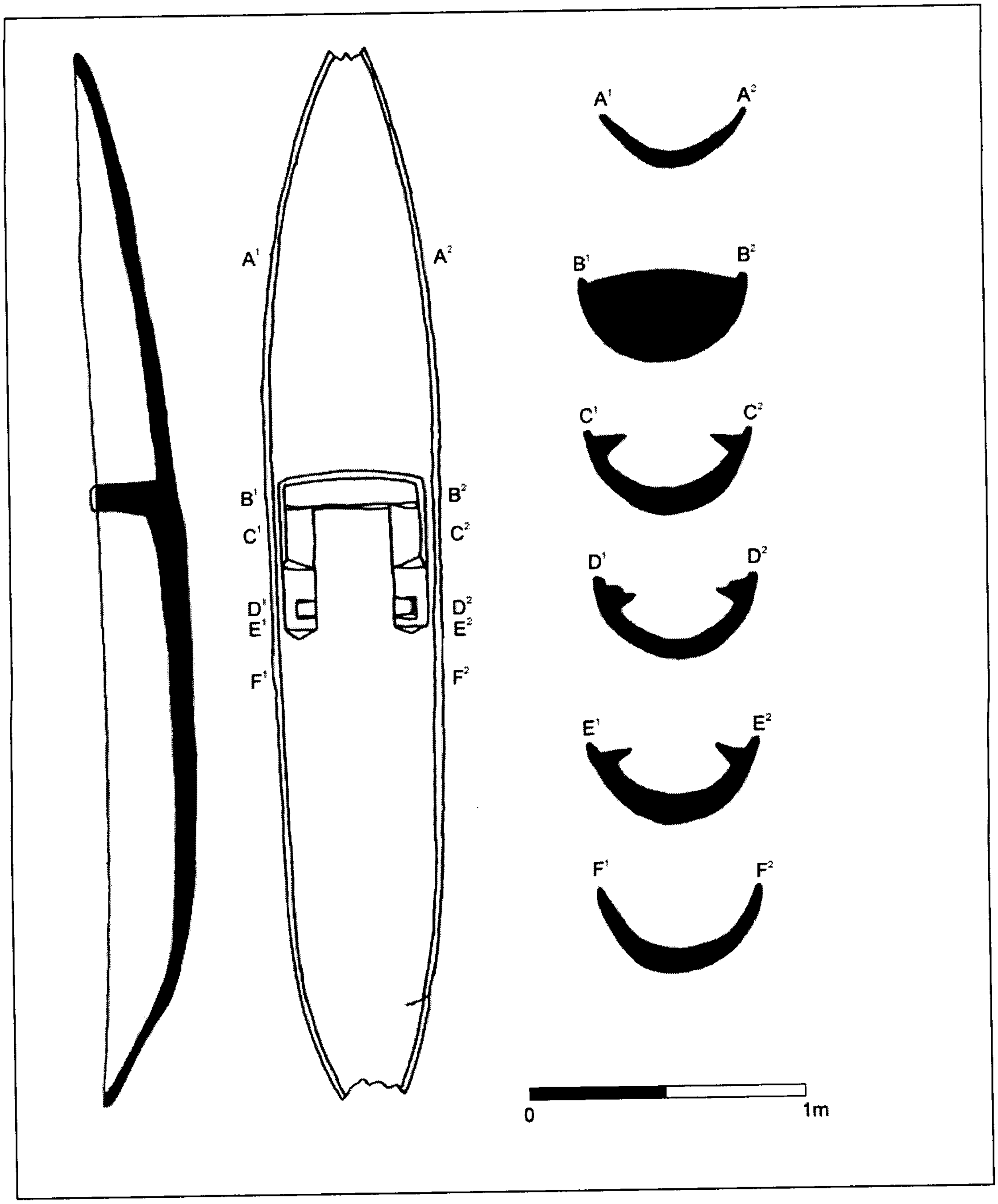

Figure 47. Spitihněv Vessel (after Hrubý 1965b:124)

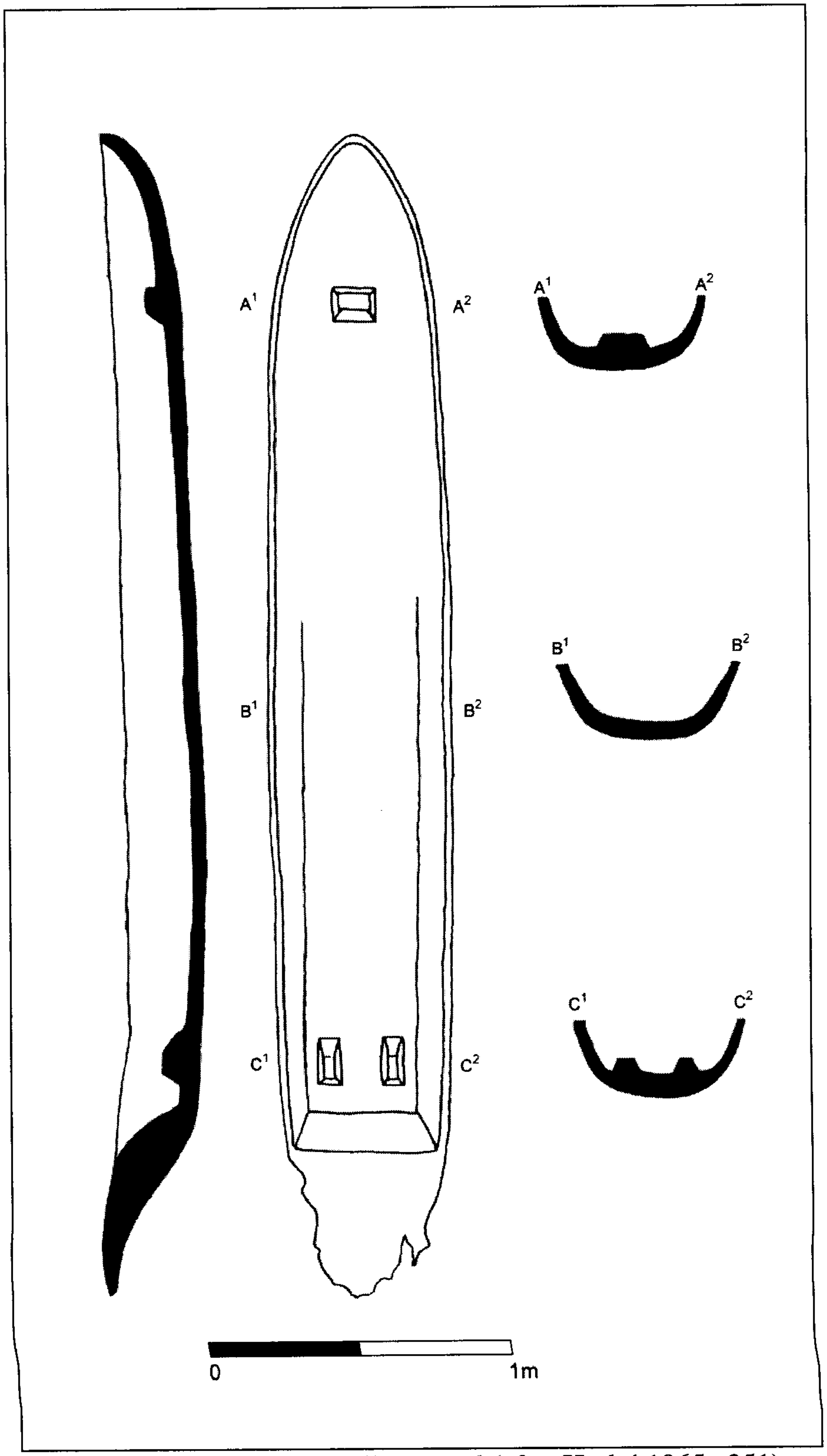

Figure 48. Uherské Hradiště Vessel (after Hrubý 1965a:251)