

The Abandonment of the Early Bronze Age Lake-settlement of Bodman-Schachen 1: A CAD and GIS Approach to the Lake-level Fluctuation Hypothesis

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Abstract

Although "lake-dwellings" existed from the middle of the fifth millennium, to the eighth century, BC, the entire phenomenon is not seen as continuous. There are, in fact, periods when the lake shores were abandoned and subsequently reoccupied. The pattern of occupation depends on cultural, as well as environmental factors, amongst them, the topography and the climate.

Unlike the southern part of the Alps, which seems to have had a more regular occupational pattern, throughout the Neolithic and the Bronze Age, the northern Alpine region shows a marked discontinuity, along most of the lake shores. Two relevant breaks in lake-shore occupation are known, within the northern Alpine region Bronze Age. The first occurred between the 24th and the 20th centuries, BC, and the second, from the 15th to the middle of the 13th century, BC.

The Early Bronze Age site of Bodman-Schachen 1, situated on the western extreme of Lake Constance (Germany), was abandoned immediately before the beginning of the second major occupational gap, in 1503, BC. Two other Early Bronze Age sites, namely ZH-Mozartstrasse on Lake Zurich, and Arbon-Bleiche 2, on the Swiss part of Lake Constance, follow a similar chronology in occupation; and they were both abandoned in the last decade, of the 16th century, BC.

A possible cause of abandonment is discussed in this paper, using an environmental approach, related to an abrupt change of climatic conditions, which resulted in an increase of the lake levels, which forced prehistoric populations to leave the proximity of the lake shores. Following the implications of pollen and sedimentological analyses, the transformation of the Bronze Age landscape, caused by the lake water invasion, will be simulated, with the help of CAD and GIS computer programs.

Bodman-Schachen 1, and its surroundings, is a good example of a cultural change, triggered by environmental factors. Thanks to modern computer technology, this slow process of landscape transformation can easily be simulated and graphically displayed, as it might have happened at the time.

Introduction

The lake-dwelling phenomenon, on lake Constance, was recognised soon after the fortunate discovery of the lacustrine settlement of Ober Meilen, on Lake Zurich, in 1854. The precise date of the Bodman-Schachen finding is not known, but the Early Bronze Age village had definitely been documented, by 1866. This site was first settled, towards the beginning of the second millennium, BC; after a couple of centuries of abandonment, it was reoccupied for a few decades, during the second half of the 17th century, BC; and the last occupation occurred, just before the Middle Bronze Age occupational hiatus, right at the end of the 16th century, BC.

The surrounding landscape, of Bodman-Schachen 1, consists of Lake Überlinger (the western upper part of Lake Constance) on the eastern side, and the enormous Espasinger Plain on the west, enclosed by gentle lines of hills, not higher than 600 m, a.s.l. Recent multidisciplinary studies have shown that the possible, main reason for the EBA abandonment, of Bodman-Schachen 1, at the beginning of the 15th century, BC, was the lake level rise, caused by climatic change. The purpose of this paper is, first of all, to discuss whether this theory is plausible, and to show, through computer simulations, the possible consequences of the lake

level transgression. A final objective is to deduce where those people decided to go, once the shore was left behind: did they abandon the lakes completely, or did they just shift, according to the fluctuations of the lake level?

Bodman-Schachen 1: the history of archaeological research

Four prehistoric, lake-dwelling sites, namely Bodman-Schachen 1, Bodman-Löchle, Bodman-Weiler 1, and Bodman-Weiler 2, had been discovered in the Bodman-Schachen area, by the end of the second half of the 19th century. There are also two more minor sites located near Ludwigshafen, and one in the Bodman-Blissenhalde area, on the south-eastern shore of Lake Überlinger (Fig. 2).

Recorded discoveries began in 1854, when forester Ley found some prehistoric lake-dwelling artifacts in his backyard. That year, as also on Lake Zurich, the water level of Lake Constance dropped drastically and wooden piles, as well as artifacts, became visible in the shallow water. Ley did not publish any report until 1866, but the discovery was mentioned in the second *Pfahlbaubericht*, written by Ferdinand Keller (1858).

Although serious archaeological studies may be said to have begun with Dehoff's report, in the fifth *Pfahlbaubericht*, right in the 1860s (Keller, 1863), scientific research was not applied immediately, and no stratigraphic recording was done. Even during the first decades of this century, work carried out by Paul Weber, in the 1920s, by Reinert, in the 1930s, and Maier (1955), in the 1950s, was essentially based on artifact analysis, without any systematic excavation. For some reason, the lake-dwelling sites around the Bodman area remained poorly researched, until the beginning of underwater expeditions, carried out by the private, antiquity collector, Menzel, in the early 1970s. This was the starting point for underwater archaeology, which considerably developed with the PBO *Project Bodensee Oberschwaben*, during the 1980s. The last two excavation campaigns, with detailed multidisciplinary scientific research, were carried out by Joachim Köninger in 1982-84 and 1986 (Köninger, 1996).

Chronology and occupational patterns of Bodman-Schachen 1

The chronology of Bodman-Schachen 1 is based on sedimentological, dendrochronological, and typological data, and three phases of occupation can be identified. The first phase occurred in the Early Bronze Age, during the 19th century, BC. The second took place in the 17th century, and, more precisely, between 1640 and 1610, BC and finally, the third, and last occupation, developed at the brink of the 15th century, BC, just before the MBA lake-dwelling hiatus (15th-13th centuries BC).

The initial occupation period, of the first phase, is reflected by the anthropogenic layer A, which is both preceded and followed by natural lake sediments, with no traces of human industry. This is clear evidence of abandonment. The time span of the second occupational phase covers more than forty years, and, dendrochronologically speaking, has two sub-phases of tree felling and three, of house construction, all within 1640 and 1590, BC. There are three layers of human industry, namely B1, B2, and C. Phases B1 and B2 are straight, one after the other, whereas B2 and C are separated by a stratum of natural lake deposits. Phase three registers only a short period of occupation (less than two decades), but, since it was left behind in 1503, just at the brink of the MBA, "missing period", it is of crucial importance for the understanding of this general phenomenon of abandonment (Köninger, 1993, 1995, 1996 and 1997). The sequence of the above-mentioned, occupational pattern is clearly shown in the Köninger's sketch (Fig.1).

Topographic and geological aspects of the Bodman-Schachen 1 area

The lacustrine settlement, of Bodman-Schachen 1, is located on the extreme north-western shore of Lake Constance, also known as Lake Überlinger (Fig.2). The site's surrounding area consists of an enormous flat land called, *Espasinger Niederung*. The plain was part of Lake Constance, during the post-glacial time; in fact, geologically speaking, underneath a few strata of alluvial and colluvial deposits, it consists of an

accumulation of calcareous deposits (*Seekreiden*), which were laid down by melting glaciers (Göttlich, 1971). All this extremely flat area is surrounded northerly, easterly, and southerly by medium-height hills, namely the Stockach Range (north) the Hamburger Hills (west), and the Bodanrück (south). The eastern side is the north-western shore of Lake Constance. The general morphological aspect, of the above-described area, is better shown by a GIS IDRISI raster image, generated from a CAD digitised, contour map (Fig.3). Lake Constance is represented by the colours black to light blue; the green area is the Espasinger Plain, and the colours yellow to dark red show the surrounding hills.

The plain is cut through by two main rivers: the River Stockacher Ach, flowing west to east into Lake Constance, and the River Dettelbach, coming from Bodanrück Hills and connecting with the River Stockacher Ach, right where the so-called, *Grosse Ried* is situated. The delta of the River Stockacher, on the western shore of Lake Überlinger, does not now occupy the same position as it did in the past. Today, it is marked by the little Achhorn peninsula (created by its fluvial sediments), whereas in prehistoric time, it was situated about 700 metres northwards, near the other little peninsula of Schachenhorn (Erb, *et al.*, 1961).

Although the changes have been fairly limited, the Espasinger Plain has not maintained the same elevation contours, throughout the past few millennia: most notably the *Grosse Ried* Basin has been filled in with sediments, by a combination of alluvial, colluvial, and fluvial activity. The soil composition, within the plain, is of medium quality in the central part, improving in fertility, towards the edges, where it is dryer. There are two outlets from the plain, created by the melting waters of the Rhine glacier, during the late-glacial time (after 18000 BP). One lies northwards, following the river bed of the River Stockacher and connecting to the Danube Valley, and the other, southwards, where the flat area continues through a narrow passage, until the Singen Plains (Schlichtherle, 1985).

The EBA settlement, of Bodman-Schachen 1, is situated on the little peninsula called, Schachenhorn, which was formed by fluvial accumulation. The surviving wooden posts lie in a shallow water environment, at about 120-160 metres from the present shoreline, at 395.5 metres a.s.l. This shallow-water zone extends down to the 392 metres, a.s.l. Since the prehistoric dwelling is situated at 393 metres, a.s.l, it is at present, submerged all the year around.

Climatic change and lake level fluctuations: GIS simulations

Palaeoclimatological studies, based on dendrochronology (Bortenschlagen, 1977; Furrer, 1977 and Rennen, 1982) pollen analysis (Burga, 1979, 1987, 1988, 1991) and sedimentology (Joos, 1976, 1982, 1991; Magny, 1980, 1992) have shown that increases in humidity and precipitation, within the catchment-area of a lake, are directly reflected in lake levels. These lake-level transgressions are believed to be the main cause, which forced the EBA lake-dwellers of the

Lake Constance region to abandon the lake shores and settle further inland, at the end of the 16th century, BC.

Research, carried out by Gamper and Suter (1982) and Jacomet (1985), has shown that within the Lake Zurich region, the lake level fluctuated considerably from 4000, BC, to the present (Fig.4). These water-level variations were mainly related to changes in climate. Towards the end of the 16th century, BC, the humidity began to rise, precipitation increased, and initiated lacustrine transgression. However, as Joos (1982) argues, climatic factors are not the only reasons for the lake-level changes. Land use and deforestation, for example, can easily alter the hydrologic balance of lakes and rivers; in fact, the process of forest clearance, associated with agricultural activity, reduces the permeability of the ground, and consequently, more water reaches the lakes, causing them to rise (Gross and Ritzmann, 1990).

Since Lake Constance has a similar climate and comparable setting to Lake Zurich, it is very likely that an analogous situation happened in the Bodman Schachen area. A confirmation comes from pollen and sedimentological analyses, which show that there was a fairly intense deforestation along with cultivation and plant domestication, around the Espasinger Plain, throughout the Early Bronze Age (Rösch, 1990). A remarkable similarity is that, according to dendrochronology, the EBA lake-villages of Bodman-Schachen 1 (Lake Constance) and ZH-Mozartstrasse (Lake Zurich) were both abandoned in the same year, namely 1503, BC. If we compare this date with the graph of Fig.4, it can be seen that the two sites were occupied, immediately before a significant rise in the lake level.

At this point, an obvious question arises. How much did the level of Lake Constance, near Bodman-Schachen 1, fluctuate? Unfortunately, there is no straight answer to this question. What can be done instead, are some computer simulations to show, graphically, the impact of the flooding water on the landscape.

The following four maps (Fig.5, Fig.6, Fig.7 and Fig.8) based on elevation contour lines, have been digitised, using AUTOCAD, and exported in GIS ARCH.VIEW 3.0, whereby flood simulations have been represented, by differentiating colour and thickness of the contour lines, themselves. Light blue lines have been adopted, to show the lake level altitude as it was, during the Early Bronze Age (392 metres a.s.l.), dark blue, thicker lines display the possible lake water level variations (fluctuations), green lines are the reasonably flat land (from 396 to 405 metres, a.s.l.) and the brown ones, the surrounding hilly area (410-550 metres, a.s.l.).

Before explaining the computer simulations, based on the rising of lake levels, it has to be pointed out that the maps' digitised contours are the present contours. Even though the surface of the plain has not been modified, to any extent, by human activity, alluvial infilling has occurred and, consequently, has changed the elevation lines, which no longer correspond to those of the Early Bronze Age.

The first map (Fig.5) shows the lake level (light blue lines) in the Early Bronze Age, at 392 metres a.s.l. (the black dot is the Bodman-Schachen 1 site). In the second map (Fig.6), it can be noticed that the Schachenhorn peninsula disappears almost completely, if the lake level is raised to today's level (395.5 metres, a.s.l.). Once the lake water reaches the flat land, one can see that a couple of metres increment of the lake level, from the present maximum, is enough to flood a good quarter of the entire plain (Fig.7). At the 400 metre-contour line, which is thought to be the maximum flood extension (Schlichtherle, 1995), the entire plain is covered in water (Fig.8). Considering that during the Early Bronze Age, the plain was in places somewhat lower, it can be argued that 3-4 metres of lake level increment (from the EBA level of 392 m, a.s.l.) should have been enough to flood the whole plain.

The "inland shift": MBA settlements around Lake Constance and Lake Zurich

A striking feature, of the chronological chart of lake-dwellings, is the complete lack of archaeological evidence of human occupation, along all the northern, Alpine region lake-shores, during the Middle Bronze Age (15th to 13th centuries, BC). Although it is too hazardous to state for sure that the exodus from the lake shores was homogeneous and sudden all over the region, there is evidence for a landwards movement of EBA lake-dwellers. Middle Bronze Age land-settlements, north of the Alps, have always been known, but recent discoveries of some MBA sites, in the very proximity of the lakes, have reopened the issue of whether or not these settlements should be regarded as lake-dwellings, or at least of lacustrine origin.

Around Bodman-Schachen area, for example, in a locality called *Breite*, a Middle Bronze Age settlement has been found at an altitude of 404 metres, a.s.l. and about 400 metres away from the present shoreline of Lake Constance. Unfortunately, the dates obtained from the site are not very precise: some pieces of organic material have been ¹⁴C dated, but the total absence of wooden structures has not allowed a more precise estimate, using dendrochronology. As a result, the chronological position of the prehistoric site is mainly based on pottery, typological analyses (Schlichtherle, 1995).

Moving further inland, a few other relevant MBA sites have been found, at Hilzingen and Mühlhausen-Ehingen, in the City of Constance province. As in the case of the MBA settlement, in locality *Breite*, the chronology of these two sites relies on pottery typology, with no possibility of dendrochronology application (Dickmann, 1988, 1990; Aufdermauer and Dickmann, 1994).

On the Swiss side of the City of Constance area, an archaeological survey, preceding the construction of the motorway, N7 Schwaderloh – Kreuzlingen, has revealed a few MBA sites, Kreuzlingen-Wildenwis, Saubach-West, and Kreuzlingen-Schlossbühl. Due to a combination of factors, such as a slightly different pottery typology, lack of dendrochronological analysis, distance from the shoreline (about 2-3 km), and the fairly elevated location of the

settlements (above 500 m, a.s.l), it is still difficult to be able to classify them as "former" lake-dwellings. A similar situation is found on Lake Zurich where a number of MBA settlements have been located, either in the surrounding hills of Meilen and around the Zurich City area. In fact, apart from Erlenbach, which shows evidence of lacustrine origins, all those sites have been listed as continuations of already established EBA land settlements. Only further studies will be able to determine whether this is right or wrong.

Good archaeological evidence of EBA lake-dwellers, moving away from the lake shores and settling further inland, comes from Lake Zug, some 15 miles south of Lake Zurich. In fact, a fairly high number of MBA sites have been found, in the immediate surroundings of the lake. Some of the most important ones are those of Hünenberg-Chämleten Luzernstrasse, Cham-Eich Zugerstrasse, Steinhausen Schlossberg, Steinhausen-Eschenmatt, Baar Altersheim Martinspark, and Cham-Oberwil Hinterbüel (Fig.9). The occupational patterns, of some of them, are particularly relevant because, as is the case of Cham-Eich Zugerstrasse, Cham-Oberwil Hinterbüel and Steinhausen Schlossberg, the settlements were occupied throughout the MBA lake-dwelling occupational "gap" (15th-13th centuries BC), and also part of the Late Bronze Age (12th century BC), before the lake shores of the northern Alpine region started to be resettled (Hochuli, 1995; Gnepf, 1995).

Conclusions

The Early Bronze Age lake-village, of Bodman-Schachen 1, occupies a crucial position within the Bronze Age lake-dwelling archaeology, in the northern Alpine region. It is, chronologically speaking, situated at the brink of the 15th century, BC, just before the MBA lake-dwelling occupational hiatus and it is particularly relevant for the understanding of the possible factors, which might have triggered this prehistoric exodus from the lake shores. Multidisciplinary research has confirmed that one of the main causes of abandonment could well have been related to environmental and climatic change. Weather conditions, causing a rise in lake levels, forced EBA lake-dwellers to abandon the immediate proximity of the lakes.

Although the exact limit of the transgression during the Middle Bronze Age, is unknown, the impact of the flooding water, as simulated through GIS ARCH.VIEW 3.0, has shown that (because of the extremely flat morphological structure of the Espasinger Plain), only a few metres of lake level increment would have been enough to flood an enormous amount of land around the Bodman-Schachen area. The fact that the EBA lake-dwellers were forced away from the lake shores is confirmed by the number of MBA "land" settlements, found near Lake Constance and Lake Zurich. Because these MBA villages have not been preserved, by continuous waterlogging, it is difficult to determine whether or not they can be classified, in some sense, as lake-dwellings. However, there is still a strong possibility that some, at least, are of lacustrine origin.

In conclusion, it can be stated that the lake-shore "exodus", at the end of the 16th century, BC, did certainly take place. Equally, some lacustrine groups did not abandon the lake shore completely, they just shifted along with the lake level fluctuations, settling the most suitable land, within the surroundings of the lakes.

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