Damage to Logs and their Preservation during the Reconstruction of the Araišu Lake Fortress

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Paper presented at the 5th liveARCH Meeting, skills training, 26.09.2008

Ladies and Gentlemen!

Lake fortresses constitute a specific category of archaeological monuments in Latvia which are different from other types of monuments due to their location in lakes, their level of preservation and close ties to folklore. There are currently ten known lake fortresses in Latvia. The remains of the lake fortresses are found at a distance of 50-100 metres from the shore, normally at depths between 1,5 and 3-4 metres. Only in three lakes the remnants surface some twenty centimetres above the water level.

To date, the most thorough research has been carried out at the Araisu Lake Fortress. The lake level was lowered by 1 metre. After this, dykes were thrown up around the excavation areas, using the excavated earth, and the lake-water was pumped out using motor pumps. Working in polder conditions during ten seasons of excavations, a team of experts, led by Janis Apals, excavated three quarters of the Araisi Lake Fortress – an area of the cultural layer measuring about 2500 (*square metres)m2, as well as the approximately 80 metre long causeway connecting it with the shore.

The Araisu Lake Fortress was built in five separate building phases that followed one another without interruption. Radiocarbonation dating indicates that the first and earliest bulding phase is about 1120 years old, while the final one 890. It means that the Araisi Lake Fortress was built and inhabited by the largest of the ancient Latvian peoples – the Letgallians - in the 9th-10th century, corresponding with the Viking Age in Latvia.

During the excavations, it was found out that the lake fortress was built on a low island, prone to inundation, connected with the lakeshore by a stony bank. When the lake fortress was first constructed, a lattice of logs was first built on the island, measuring about 28 x 25 metres, its height varying between 0,5 and 1,5 metres. The platform constructed in this way served to raise the structure about 1 metre above the water, protecting it from fluctuations in the lake level, providing drainage and forming the basis for the arrangement of the buildings.

The houses had been arranged in pairs around the perimeter of the rectangular platform and an additional row of wooden dwellings, as well as a few outbuildings, were built in the middle of the platform. The defense structures were arranged in levels. At the upper level was a walkway built along the outer edge of the platform, at the lower level around the outside of the terrace was a wall of horizontal logs reinforced with posts, and with chamber-like structures on the terrace.

The good condition in which the first construction fundaments were preserved showed that the Araisu Lake Fortress had been neither a classic pile-dwelling, with the bearing platform based on piles vertically driven into the bottom of the lake, nor a planking settlement, which is built on several rows of horizontally arranged log planking. The constructive solution employed in the Araisu Lake Fortress is thus of a third variety, a mixture of the above-mentioned construction type.

But how did the remnants of the lake fortresses become submerged and preserved under water? Is there truth in the folk tales claiming that they were drowned by a lake flying over the area and after someone had guessed its name, the lake fell from the sky?

After thoroughly researching the foundations of the Araisu lake fortress, it was concluded that there were two main reasons for this, the first being that the foundations, permanently exposed to moisture, became deformed and settled under the weight of the structure; the second that the rise

of the water level of the lake was due to climate change. The old buildings were preserved under water, but their visible presence kept alive in Latvian folk tales.

The dwellings in Araisi represent an archaic form of log structure, displaying methods of construction no longer found in Latvian etnographic architecture, but which are found in ethnographic buildings of other Northern and Northeastern European peoples. Already during the excavations in 1966, the idea of reconstructing the Araisu Lake Fortress into an open-air archaeological museum was presented. The idea was widely supported and so, in 1985, the archaeologist J. Apals and architect Dz. Driba drew up a plan for the first constructions of the reconstruction of the Araisu Lake Fortress.

The project planned for their reconstruction as an open-air model on the original site of the Araisu lake island, the location being moved only slightly closer to the shore in order not to damage the yet unexplored parts of the remnants. The plan was to re-build the foundations as copies of the original structures and to construct the upper parts based on construction details found in the cultural layer of the lake fortress, constructive logic as such and by drawing parallels to ethnographic buildings of other Northeastern European populations.

Both the foundations and the buildings were mainly built using spruce trunks, but pine, oak and birch were also used to some extent. The dwellings were built from straight and smooth spruce beams only slightly differing in diametre at the thick and the thin end of the tree. Some buildings used logs with the bark left on, but others, especially grander structures and dwellings from the later construction phases, used peeled logs. The gently-sloped roof was of roundwood covered with sheets of spruce or birch bark and weighted down with round logs or boards. According to dendrochronological dating, the building phases followed one another at an interval of 15-17 years. This could be indicative of the life-span of each building.

The tools used in the construction were the universal tools of that time – narrow-bladed iron axes, socketed chisels, drills and draw-knives, as well as wooden wedges, mallets, levers and ropes braided from bast string.

To ascertain means of reconstruction, an experimental building was erected in 1981. The lower parts of the house were built in February and March while the upper parts were built using green spruce logs, chopped in July, with the bark still on. This test building stood until 1995, when it threatened to collapse and was deconstructed. During the deconstruction process it was established that the most damage done by rot was to the yoke timbers, the spruce bark below them and the yoke corner joints. The logs in the lower parts were more or less rotten, but the green built-in logs were well preserved. On the outside, because of the sun, the bark had scaled off and the logs were deeply cracked, while on the inside, the bark had dried and stuck to the walls so that it could not be removed, resembling wallpaper made of hide.

In choosing the materials for the reconstruction of the lake fortress, the builders strictly observed the original original data, although they had to depart from them slightly with regard to the type and size of trees used. For example, to avoid the sagging of the foundation, a concealed concrete girder lattice was substituted for the round-tree log foundation lattice.

The construction platform was built from 10-12 cm thick spruce logs, dwellings from 12-15 cm thick spruce logs. The round-tree or plank ceilings were covered with birch or spruce bark, which was held fast with round-tree yoke timbers. Three buildings were covered with a sod roof.

The timber used for building some dwellings was impregnated, while others were built using non-impregnated timber. This was done in order to ascertain differences in length or preservation. The timber used for the platform was not impregnated. In the beginning, until 2002, the timber was processed using „Erlit“, a mixture patented as a biological means for protecting trees from catching fire. The timber was soaked at the construction site in a bath containing 25-28% „Erlit“.

After 2004, the timber, especially the timber used for the foundation layer, was impregnated in autoclave, using the fluid „CCO“. In 2008, the timber was soaked in the same autoclave using the mixture „Tanalit E“ instead.

During the 20 years of the reconstruction of the Araisu Lake Fortress, experience has been acquired, beginning with the building of the first experimental house in 1981. During this period of time, from 1990 onwards, several tree chemistry experts (especially Dr. Irena Luse) have, monitored the „behaviour“ of the reconstructed lake fortress. Damage to the reconstructed buildings does not show up immediately, but appears only after a certain period of time. Damage also varies between different kinds of trees, including differences between various types of conifers. Both spruces and pines are equally good at bearing vertical pressure, but they differ with regard to horizontal pressure. The spruce is more flexible and elastic, while the pine is more fragile. The pine starts to decay from the kernel, with the sapwood decomposing last, while the spruce sapwood starts to decay first, the kernel being the last to decompose. This explains the differences in damages at different points in reconstruction.

Ten years after the beginning of the reconstruction works, in the year 2000, a quality control laboratory established that due to the oscillation of the water level in Lake Āraiši (in the spring and summer seasons up to 0,7 metres), the reconstructed wooden structures had been subjected to so called „soft“ fungus rot. In places with heightened levels of moisture, algae were growing on the constructions. The wear on the round-tree deck of the platform was due to the large numbers of visitors coming to the rebuilt lake fortress, while the surface of the wood has become completely dark-grey due to the breakdown of photosynthesis.

Seventeen years after construction began, in 2007, an in-depth study was conducted in the abovementioned chemistry library. The study found out that biodegradation in the Araisu Lake Fortress was caused by the wood decay fungus *Gloeophyllum sepiarium* which was found in the deck of the platform, on the deck of the porch and street as well as both on the inside and outside of seven dwellings.

Gloeophyllum sepiarium is often found in constructions which use poles. They are wood decay fungi that cause a brown rot. The woodpulp is disturbed from the inside outwards, which means that no real signs of the destruction process may be noted on the outside. These fungi normally infect wood that has repeatedly become moist and dried up. Therefore one can say that humid conditions develop in the wood, since the fungi develops and grows at temperatures above 25C. The wood becomes infected through cracks and the fruitbody of the fungus is seen only after 2-3 years after infection.

In some local parts the wood is damaged also through the purple jellydisc *Ascocoryne sarcoides*, which grows in the autumn and winter. It doesn’t cause deep damage to the wood. The green algae *Pleurococcus vulgaris* adds moisture to the wood, therefore causing a beneficial atmosphere for the growth of fungi. The ambiguous bran lichen *Parmellopsis ambigua* grows on heavily acerbic tree bark, on the base of pine trunk as well as on rotting wood.

Since the second half of the 1990:s, each year renovation and reconstruction work has been done on the platform and dwellings and continues to this day. When summarizing the experience obtained by building and renovating the Araisu Lake Fortress, and taking into account the analysis made by wood specialists, the following conclusions can be drawn:

The main reasons for damages to the rebuilt platform and other buildings are:

1) being subject to constant moisture;
2) the lack of ventilation in the foundations;
3) the strain of the many visitors, specially on streets and passages.

To these reasons one also should add the lack of heating in the housing areas, since the smoke from the smokerooms also acts as a natural conservant of the upper levels of the houses. A part of the damages can also be explained by the properties of the types of wood used, and to a large extent, to faults in the rebuilding construction work. The life-span of the reconstructed buildings is still less than that of the originals, but it could be increased by choosing more durable and better impregnatable types of wood, as well as improving the conditions for the preservation of the buildings.

Thank you for your attention!