

NEOLITHIC COPPER ARTEFACTS FROM THE CANTON OF LUCERNE (CENTRAL SWITZERLAND)

The earliest copper finds in Switzerland are usually associated with the emergence of the middle Neolithic Pfyn Culture. This culture is dated to the period between approx. 3900 and 3500 BC in eastern Switzerland. At around 3800 BC it replaces the Cortaillod Culture at Lake Zurich and Lake Zug, and thus in the eastern part of central Switzerland, as well (Stöckli 2009, 203; Hügi 2006).

From approx. 3750 BC copper artefacts and local copper processing are known in the Swiss sites of the Pfyn Culture. In neighbouring southern Germany, some imported copper finds are known as early as between 4300 and 4200 BC (Leuzinger 2007, 188; Schier 2010; Klassen 2010; Strahm 1994; Fasnacht 1995). During the late Neolithic Horgen Culture (approx. 3300-2800 BC), copper finds are rare in eastern and central Switzerland, and evidence of processing is only sporadically established. According to recent excavations at Lake Zug and Lake Zurich lack of evidence seems to be the result of a gap in the research (Gross/Schaeren 2013, 54; Altorfer/Affolter 2010, 300).

In western Switzerland copper artefacts appear in significant numbers from the onset of the late Neolithic Lüscherz Culture, and thus from about 2900 BC and onwards. A few well dated finds are older, though, and will be discussed below (Cattin/Villa/Besse 2009). Apparently, Neolithic copper artefacts in western Switzerland are mainly imported pieces from northern Italy and southern France (Strahm 1994, 24). Clear evidence of a local Neolithic copper processing, for example crucibles, has so far not been established in this part of the country (Fasnacht 1995, 184).

CENTRAL SWITZERLAND IN THE MIDDLE NEOLITHIC

The central Swiss canton of Lucerne is situated on the fringe between the Prealps and the central Swiss Plateau. Numerous watercourses, as well as lakes and bogs characterize the pronounced hilly landscape. Flat areas are relatively scarce, and mostly consist of dried out lakes, mires or river valleys. At present in excess of 30 Neolithic lakeside settlements, so-called pile dwellings¹, are known from former lakeshores in the canton of Lucerne. The cultural layers are imbedded in lake marl or peat. Until the wetland was dried out and the lake levels were lowered during the 19th century, the conditions for preservation of organic finds were very good. Numerous sites are discovered on dry land, but as they are not well preserved, very little is known about them. Often they are situated close to watercourses or former lakes or ponds. Finds on hill tops or even in caves indicate an intense settlement system comprising more or less the entire area (Nielsen 2012).

Central Switzerland is an archaeologically very interesting area (fig. 1). During the Neolithic the boundary between the maximum expansion of the Pfyn Culture and the late Cortaillod Culture is situated here (Stöckli 2009, fig. 112). The Pfyn Culture descended in southern Germany and eastern Switzerland at around 3900 BC and subsequently expanded to the south into present-day central Switzerland. On the shores of Lake Zug and Lake Lucerne this culture replaces the Cortaillod Culture at approx. 3800 BC (Huber/Schaeren 2009; Michel-Tobler 2010). Evidently the two mentioned cultures, which cover vast areas of southern central Europe, are not homogeneous units. Instead geographical differences can be observed (Wey 2012,

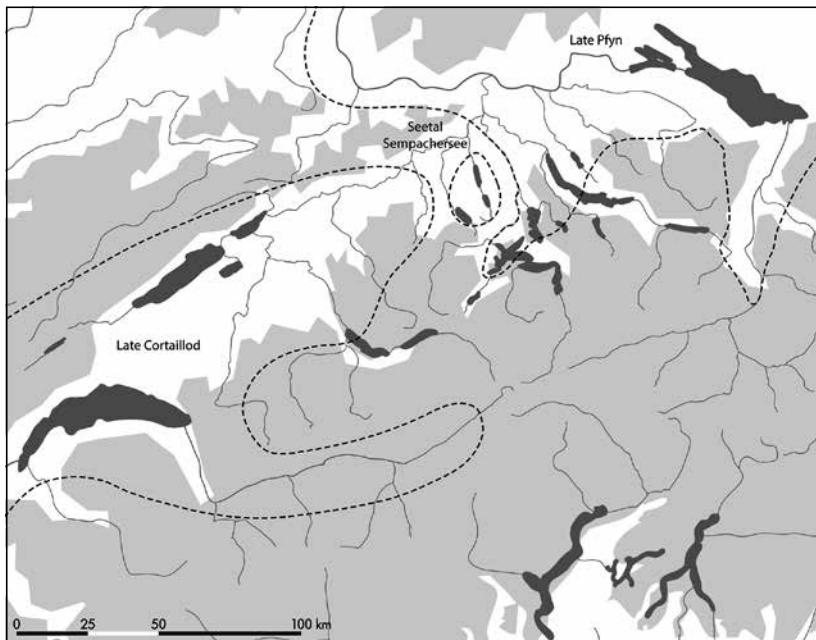


Fig. 1 Neolithic cultures at 3800–3500 BC in Switzerland. – (Illustration C. Jäggi).

138-139) as this is mostly the case for widespread prehistoric cultures. Exactly in the phase where copper processing starts in the Pfyn Culture, the culture expands towards the west and reaches Lake Zurich and parts of central Switzerland.

Long lasting exchange connections between Lake Zurich and Lake Zug, and adjacent areas to the west, are now ceasing. A good example of this phenomenon is the import of stone axes from the French Vosges Mountains. These artefacts made of diorite (»aphanite«) were imported in large quantities to central and eastern Switzerland, but the import abruptly stops here with the beginning of the Pfyn Culture (Gross-Klee 1995, 136). In contrast hereto the trade with diorite axes continues through the contemporary late Cortaillod Culture of western and central Switzerland for about 300 more years.

The Wauwilermoos bog and Lake Burgäschi see are not reached by the Pfyn Culture, and the influence of this culture remains extremely modest, especially regarding the ceramic inventories. The situation is different at Lake Sempachersee and in the adjacent Seetal Valley where the Lakes Baldeggersee and Hallwilersee are situated. In this area, Neolithic assemblages belonging to the period between 3800 and 3500 BC still can be attributed to the Cortaillod Culture. However, they show significant influences from the Pfyn Culture. This is, for example, documented by ceramics whose surface is covered by silt, which clearly is an eastern trait, and regarding vessels and ornamentation as well (Wey 2001, 189; Stöckli 2009, 89). The three lakes can therefore be regarded as a transitional zone between the two cultures during the younger Swiss Neolithic. According to current knowledge, the Reuss River and the northern shore of Lake Lucerne, form the flowing cultural boundary between the Pfyn and Cortaillod Cultures at this stage of the Neolithic.

EARLY COPPER BEYOND THE PFYN CULTURE

As already mentioned copper items and casting crucibles occur sporadically in the adjacent areas to the west (Strahm 1994; Wey 2012). A few middle Neolithic copper artefacts are known from the western Swiss lake-

shore sites as well. In western Switzerland almost all copper items belong to the late and final Neolithic. A few well dated exceptions listed below:

- Lausanne Vidy-Chavannes (ct. Vaud), grave 71: Cortaillod Culture. Copper bead. ^{14}C : approx. 3400 BC² (Crotti/Moinat/Wolf 1995, fig. 10).
- Twann Bahnhof (ct. Bern), layer OS: Cortaillod Culture. Dagger made of copper. Dendrochronology: 3596-3532 BC (Honegger 2006, 48).
- Delley Portalban (ct. Fribourg), layer 1C: Horgen Culture. Dagger with shaft hole. Dendrochronology: 3270-3090 BC (Honegger 2006, 48).
- Muntelier Platzbünden (ct. Fribourg): Horgen Culture. Crescent formed pendant. Dendrochronology: 3179-3118 BC (Ramseyer 1985, 71-72).

These items indicate that copper occurs to a limited extent and has even been processed on the eastern fringe of the Cortaillod Culture. Outside the Pfyn Culture Neolithic copper has been found in the Cortaillod sites of Lake Burgäschisee (Strahm 1994, 18), in the Wauwilermoos bog (Egolzwil 4, ct. Lucerne), and at Lake Baldegggersee (Hitzkirch-Seematt, ct. Lucerne). At Lake Sempachersee two copper items were discovered on the lake floor at the multi-period site of Eich-Spiessmöli (ct. Lucerne).

Copper artefacts in the Cortaillod wetland settlement of Burgäschisee-Süd are remarkably abundant. In the north-western part of the settlement area, two cords with a total of 54 copper beads were found (Sangmeister/Strahm 1973). The beads are interpreted as a depot of raw material rather than adornments. Chemical analysis yielded a high content of arsenic, and the metal can thus be attributed to the so-called Mondsee copper of the eastern Alps (Strahm 1994). This part of the settlement is according to dendrochronological analysis dated to the period between 3760 and 3748 BC (Wey 2012, 135), and is thus simultaneous with the earliest copper processing of the neighbouring Pfyn Culture. In addition a copper chisel can be mentioned which was found without context, and presumably belongs to the same time. Copper beads is a category which is often interpreted as a kind of ingot and apparently only occurs outside the Pfyn Culture. In this connection the beads in a grave from the neighbouring Munziger Culture in Colmar (dép. Haut Rhin/F) can be mentioned, which were also made of »Mondsee copper« (Lefranc/van Willigen 2010).

Casting crucibles found in the settlements of Burgäschisee-Süd and Burgäschisee-Ost (fig. 2) proves that local processing of copper takes place in the eastern part of the Cortaillod Culture, close to the border of the Pfyn Culture (Wey 2012, 36-37; Anliker/de Capitani/Lötscher 2010, tab. 13, 25).

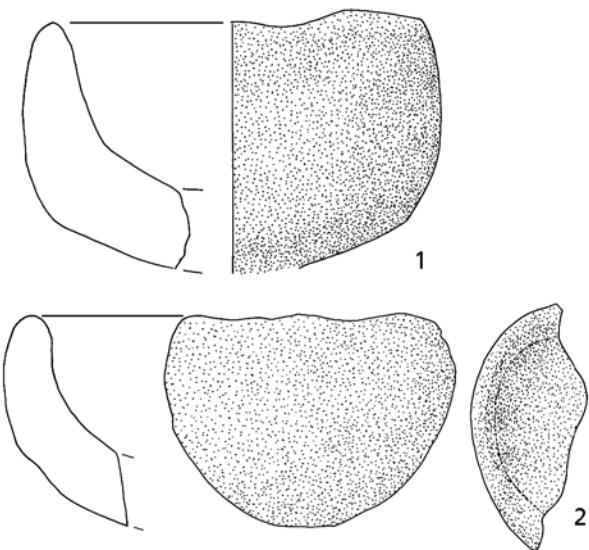


Fig. 2 Casting crucibles from Burgäschisee-Ost (1) and Burgäschisee-Süd (2) (both ct. Lucerne). – (Drawings E. H. Nielsen after Anliker/de Capitani/Lötscher 2010 and Wey 2012). – Scale 1:2.

NEOLITHIC COPPER FINDS FROM THE CANTON OF LUCERNE

On the territory of present-day Canton Lucerne six copper artefacts from four Neolithic sites are known so far (figs 3-4). Compared to Canton Zug, situated east of Lucerne (Eberli 2013; Gross/Schaeren 2013), there are rather few items. The explanation must be the presence of the Pfyn Culture in Zug, and the significantly higher intensity of archaeological survey in this canton.

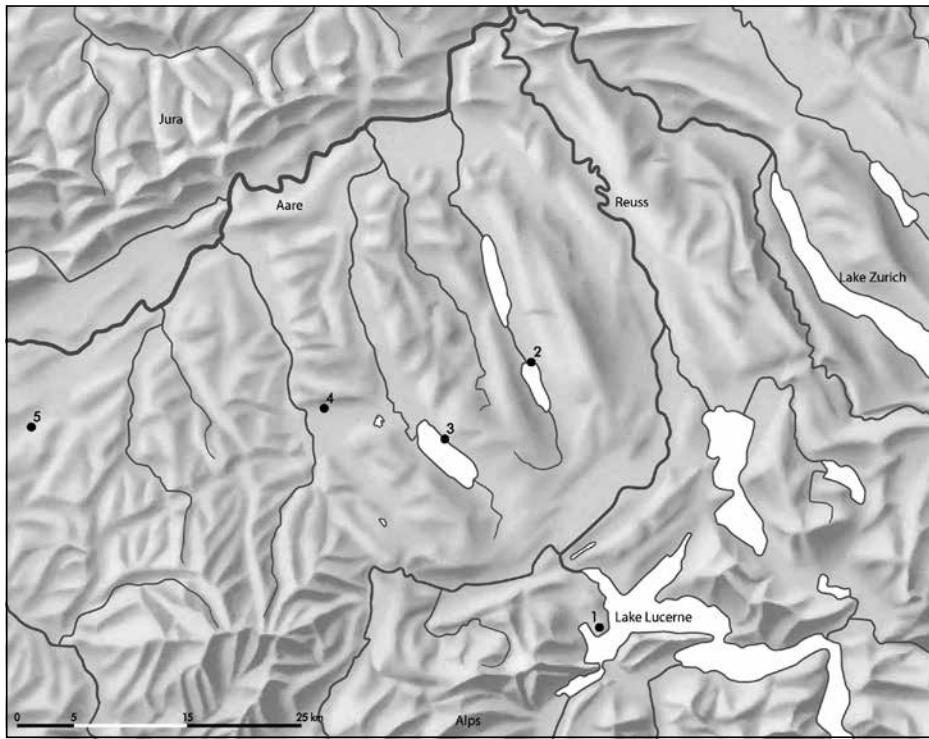


Fig. 3 Middle Neolithic sites with copper artefacts in central Switzerland:
1 Horw-Fondlenhöhe. –
2 Hitzkirch-Seematte. –
3 Eich-Spiessmösli. –
4 Egolzwil 4. – **5** Burgäschisee-Süd and -Ost. –
(Illustration C. Jäggi).

Horw-Fondlenhöhe

The Horw peninsula is situated on the northern shore of Lake Lucerne. In 1920 a copper axe was found during construction work (fig. 4, 1). According to the finder the axe came to light in the moraine, and thus probably in an unrecognized pit. Further observations concerning the circumstances were not made (Amrein 1939, 133-134).

The site is located on a hilltop at about 540 m a.s.l. The distance to the current lakeshore is in a straight line approx. 300 m. Today's lake level is 434 m a.s.l. As seen at the submerged site of Kehrsiten (ct. Nidwalden), the lake surface level must have been 7-10 m lower than today during the 4th millennium BC (Hügi 2006; Michel et al. 2012). Other prehistoric finds were not discovered in the vicinity of the site. Kehrsiten is situated 3 km from the Horw site, and is the nearest Neolithic settlement known. Thus there are no indications of the cultural or chronological context of the find.

The mentioned elongated-trapezoidal axe has slightly convex longitudinal sides. The length is 10.6 cm, the maximum width is 3.2 cm, and the maximum thickness is 1.3 cm. The tool weighs 156.00 g. The neck is thin and without a flat butt, as it is usually seen on the Neolithic copper axes in Switzerland. The cross-section is rectangularly oval with rounded corners. Vesicular protrusions on the surface can be attributed to a less than optimally successful casting process (Krause 2003, fig. 221). It is striking that one broad side – probably the upper side during casting – shows significantly more vesicular protrusions than the other broad side. Casting seams on both narrow sides are remnants of the cast in a bivalve mold. Only the clearly asymmetric cutting edge seems to have been worked over after the casting.

The axe has been mentioned in publications several times, and due to the unusual form of the artefact, secondary water rolling was initially anticipated. This incorrect conclusion can be explained by the rough surface, which is due to the lack of polishing, and the rounded edges. Polishing is otherwise almost always observed on Swiss copper axes.

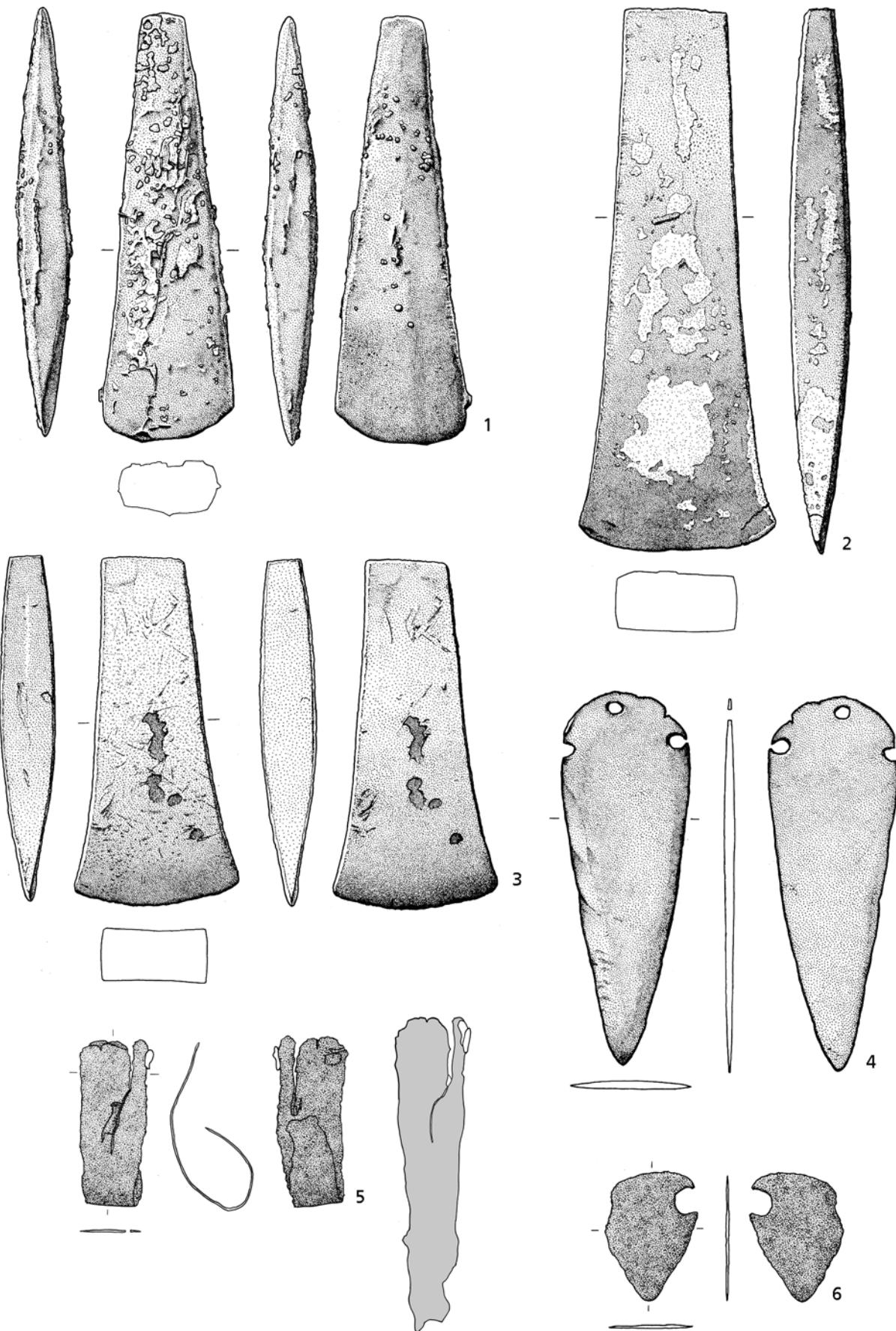


Fig. 4 Neolithic copper artefacts from Canton Lucerne: **1** Horw-Fondlenhöhe. – **2** Egolzwil 4. – **3-4** Hitzkirch-Seematte. – **5-6** Eich-Spiessmölli. – (1-4 drawings M. Bieri; 5-6 drawings E. H. Nielsen). – Scale 3:4.

	Sn	Pb	As	Sb	Ag	Au	Ni
Hitzkirch, axe							
SNM Ottoway 1982	<0.0003 0	0.0024 0	1.942 2.1	0.0016 0	0.0015 0.002	<0.0003 0	0.0134 0.01
Hitzkirch, dagger	0.0002	0.011	0.0017	0.015	0.083	<0.000006	0.0076
Egolzwil 4, axe							
SNM SNM/Wyss 1983	<0.0003	0.0009	0.724 0.64	0.1208 0.15	0.0797 0.06	<0.0003	0.0013 0.005
Eich, »dagger«							
SNM	0.00025	0.00062	0.00087	0.00031	0.0134	0.00047	0.27
Eich, »pendant«	0.000062	0.0032	0.018	0.014	0.04	0.000049	0.007
Horw, axe	<0.0003	0.0171	1.67	0.0056	0.0033	<0.0003	0.0008

Tab. 1 Chemical analysis of copper artefacts from Canton Lucerne. – SNM: Schweizerisches Nationalmuseum.

name of site	character of site	dating	arsenic content	typology	illustration
Horw-Fondlenhöhe	unknown: hill top stray find	undated	1.67 % »Mondsee«	axe	fig. 4, 1
Egolzwil 4	»pile dwelling« excavation stratified	classical Cortaillod	0.724 and 0.64 % (2 analyses) »Mondsee«	axe type Kornwestheim	fig. 4, 2
Hitzkirch-Seematte	»pile dwelling« excavation stratified	classical Cortaillod	1.942 and 2.1 % (2 analyses) »Mondsee«	axe type Thayngen	fig. 4, 3
Hitzkirch-Seamatte	»pile dwelling« stray find	undated Cortaillod? Horgen?	0.0017 %	dagger type Cucuteni?	fig. 4, 4
Eich-Spiessmösli	»pile dwelling« stray find	undated Cortaillod? Horgen?	0.018 %	copper sheet pendant?	fig. 4, 5
Eich-Spiessmösli	»pile dwelling« stray find	undated Cortaillod? Horgen?	0.00087 %	copper sheet dagger?	fig. 4, 6

Tab. 2 Copper artefacts from Canton Lucerne.

A Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) analysis was initiated in 2014 by the laboratory of the Schweizerisches Landesmuseum in Affoltern am Albis (ct. Zurich)³ showing the chemical composition of the copper noted in **tables 1-2** (Günther et al. in print). The high content of arsenic suggests an eastern Alpine origin of the metal, despite certain differences in trace elements. Comparison of this result with recent analyses of central European Neolithic copper indicates that the axe was produced with R. Krause's I Class »tetrahedrite with nickel« (Krause 2003, fig. 40) or »class 12« of Ph. Lefranc et al. (2012, tab. 6).

On a list published by E. Sangmeister and Ch. Strahm (1973) the piece is attributed to their typological group of »Thayngen copper flat axes«. Comparing these axes with the find from Horw this attribution is rather difficult to explain. According to archive records of the Kantonsarchäologie Luzern, the researchers did not analyse the object personally, and the metric details thus seem to have been submitted to them by the local authorities. The attribution to the »Thayngen axe type« was thus probably undertaken according to the measurements, but must be rejected due to the typological attributes which are totally different.

Bi	Co	Zn	Fe	Se	Te	Mn	Cd	Cu
<0.0006	<0.0003	0.0007	0.0016	<0.0017	<0.0006			98.037
0.0005	0	0	0.001					
0.0042	0.000045	0.00085	0.005	0.012	0.0008	0.0003	<0.00019	99.8465
0.0206	<0.0003	0.0009	0.0017 0.05	<0.0010	<0.0006			99.05 99.1
0.00015	0.00095	0.000394	0.0049	0.0042	0.00083	0.00026	<0.00014	99.6903
0.00028	0.000032	0.00048	0.006116	0.005	0.00019	<0.00013	0.0004	99.8987
<0.0006	<0.0003	0.0026	0.0107	<0.0015	<0.0003			98.29

The Horw find is rather comparable to the eastern and northern copper axes of the so-called type Kaka. The distribution of these axes can be seen on **figure 8**. There might be a comparable find from northern Italy, as well, which regrettably not can be situated (Klassen 2000).

According to L. Klassen the metal used suggests an origin of the northern and eastern European axes in the Slovakian Ore Mountains (»Slowakisches Erzgebirge«) (Klassen 2000, 99; Klassen/Dobeš/Pétrequin 2008–2009, tab. 1; Klassen/Cassen/Pétrequin 2012). The metal used for the production of the Horw axe can be attributed to »class 12« of the scheme suggested by Ph. Lefranc et al. (2012), and an origin of the copper from an eastern Alpine ore can thus be anticipated.

There are so far only typological considerations available as a basis for dating (Klassen 2000, 102). L. Klassen proposes a dating of the Kaka-axes at around 4000 BC as most likely. According to Ch. Strahm a somewhat earlier period in the second half of the 5th millennium BC cannot be excluded (Strahm 2010).

Hitzkirch-Seematte

The predominantly Neolithic lakeshore site Hitzkirch-Seematte is situated on the northern end of Lake Baldeggersee, approx. 402 m a.s.l. A large number of sites occupy an approx. 500 m long part of the lakeshore. These settlements can be dated to the early and classical Cortaillod Culture and to the Horgen and Corded Ware Cultures as well. A few finds can be attributed to the early and late Bronze Age.

During the early 20th century numerous minor excavations were conducted by amateur archaeologists, mostly without any kind of documentation. In 1938 the first and so far only excavation with documentation to the archaeological standard of the period was conducted in Hitzkirch-Seematte (Bosch 1939). Since the early 1980s a huge assemblage has been collected from the lake floor by divers and on the shore as well. These finds derive from cultural layers eroded by the water current and during storms. The reason for the erosion is the artificial lowering of the water level in the 19th century by approx. 2 m.

During the campaign in 1938 approx. 600 m² were excavated, which constitutes only a minor part of the site. A thin lower layer was 15 cm thick and an upper multi-phase layer between 50 and 170 cm thick (Wey 2001, 88; Bosch 1939). The lower layer can, according to typological analysis by O. Wey, be attributed to the early Cortaillod Culture and thus to the period around 4000 BC. Dendrochronological analysis allows a dating of the upper layer(s) to between 3825 and 3758 BC. These results confirm the typological study by O. Wey, which attributes the ceramics to the classical Cortaillod, and thus to the late 39th and the first half

of the 38th millennium BC (Stöckli 2009, 88). The long period indicates that the layer contains multiple settlement phases.

Copper axe

A trapezoidal copper flat axe was recovered in the upper layer (fig. 4, 3), and belongs thus to the early phase of copper in the region. In addition to the flat butt, the axe has a rectangular cross-section, slightly concave broad sides and slightly convex narrow sides. The axe was attributed by Ch. Strahm to his type Thayngen (Bosch 1939, 8-9; Strahm 1994, 18). The length is 8.17 cm, the maximum width 3.86 cm, and the maximum thickness 1.24 cm. The weight is 156.47 g. The raw material was analysed as part of the so-called SAM project (Ottaway 1982, 246 fig. 4e appendix XXV [4] SAM 7293).

Chemical analysis of a core sample revealed a high arsenic content of 2.1 %, and belongs thus to the »Mondsee copper«. A second analysis recently initiated by the laboratory of the Schweizerisches Landesmuseum (tabs 1-2) yielded 1.942 % and thus confirmed the high content of arsenic. Ph. Lefranc et al. assign the copper raw material of the axe to their »class 24«, which was until now found only in six sites between St. Blaise (ct. Neuchâtel) at the Swiss Lake Neuchâtel and the Czech Republic (Lefranc et al. 2012, tab. 7).

Copper dagger

During an underwater survey in the 1980s, a copper dagger (fig. 4, 4) was recovered along with ceramics of the Cortaillod and Horgen Cultures. The dagger is 8.76 cm long, up to 3.04 cm wide and has a maximum thickness of 0.18 cm. The weight is 18.46 g. The sharpened cutting edges are clearly convex, and the rounded grip plate is equipped with three rivet holes.

The raw material was determined by an XRF analysis (X-ray fluorescence spectroscopy) conducted only on the surface of the artefact by F. Sager. The piece seemed to consist of very pure copper without any content of arsenic. Because the apparent lack of arsenic in the result might be attributed to methodological problems, further analyses by LA-ICP-MS were conducted. The results of the XRF analysis were confirmed, since only a very minimal content of arsenic could be established.

Copper daggers are extremely rare in the Neolithic of central and eastern Switzerland. The exceptions are two stray finds from Canton Zurich (Altorfer/Affolter 2010), and some daggers recently found in late Neolithic layers in Canton Zug. Only preliminary reports have so far been published (Gross/Schaeren 2013). A dagger with three rivet holes was recovered in the multi-phase wetland settlement of Greifensee-Storen »Wildberg« (ct. Zurich). In this site the Pfyn, Horgen and Corded Ware Cultures are recorded, and there are consequently no indications for the dating of the artefact. Typologically it can be attributed to the daggers of the Cucuteni type, which has an eastern European distribution (Mat uschik 1998, 213). The dagger is thus likely to belong to the Pf yn Culture. Accordingly, a high arsenic content indicates an attribution to the so-called Mondsee copper. Another copper dagger from the lakeshore site of Feldmeilen-Vorderfeld (ct. Zurich) has a grip tongue with lateral notches and good parallels with late Neolithic daggers from southern France. The metal analysis appears to confirm this origin (Altorfer/Affolter 2010, 300).

The wetland settlement Reute (Lkr. Emmendingen) in southern Germany was dated by dendrochronology to the period between 3738 and 3731 BC. A dagger found here has three rivet holes as well, but due to the slightly concave cutting edges, it has a somewhat different shape than the piece come to light in

Hitzkirch-Seematte (Matuschik 1998; Mainberger 1998). Another comparable example was found in Attersee in Austria. It is unfortunately undated, but was also made of arsenic »Mondsee copper« (Ottaway 1982, 336). It is conceivable that the concave cutting edges have been obtained by abrasion and by reworking.

In western Switzerland copper daggers are frequently seen in settlements of the Auvernier Culture and thus in the period around 2700 BC (Cevey et al. 2006; Honegger 2006; Strahm 1994). These artefacts are mainly imported from Italy and southern France, but there might be some locally made pieces as well.

Copper daggers prior to the mentioned period are scarce. Well dated finds are only known from the upper Cortaillod layer OS in Twann (ct. Bern; dated to 3596-3532 BC by dendrochronology), and from layer 1C in Delley-Portalban (ct. Fribourg). This settlement layer can be attributed to the western Swiss Horgen Culture, and was dated to between 3180 and 3130 BC by dendrochronology (Honegger 2006, 48). The Twann dagger belongs according to Ph. Lefranc et al. to their »class 4«, and thus to the so-called Mondsee copper, which has been found in 89 sites between western Switzerland and Slovakia (Lefranc et al. 2012, fig. 7)⁴.

As already mentioned copper daggers originating in northern Italy and southern France were repeatedly discovered in western Switzerland. In the central and eastern parts of the country they seem to be extremely scarce and hitherto only known from the sites of Feldmeilen-Vorderfeld and Cham-Alpenblick (ct. Zug; Gross/Schaeren 2013, 54).

It is remarkable and surprising that a converse situation is seen concerning the bifacial retouched flint daggers imported from northern Italy during the same period. They occur relatively frequently from the earliest Horgen Culture and onwards in central and eastern Switzerland, as well as in southern Germany (Altorfer/Affolter 2010; Eberli/Altorfer 2009; Nielsen 2011; Schlichtherle 2004/2005; Tillmann 1993). In western Switzerland only flint daggers made of French raw material were imported (Honegger 2006). Thus the late Neolithic cultures in the two parts of the country seem to have imported prestigious objects from the same area of origin; however, they seem to have appreciated different types of objects.

Egolzwil 4

From the shores of the now completely silted Wauwilersee we know today about a dozen Neolithic wetland sites (Speck 1990). The Egolzwil 4 settlement was fully excavated by the Schweizerisches Landesmuseum between 1954 and 1964. Although three superimposed phases were clearly visible during the excavation, the available documentation does not allow us to separate the material accordingly (Wey 2001, 21). Typologically the three phases must all belong to the classical central Swiss Cortaillod Culture, and thus to the 39th century BC (Stöckli 2009, 85 ff.).

A trapezoidal copper flat axe has a flat butt and slightly convex wide and narrow sides (**fig. 4, 2**). The axe has been attributed by B. Ottaway to the »type Thayngen«, and subsequently by Ch. Strahm to his later defined »type Kornwestheim« (Ottaway 1982, 246 fig. 4h; Strahm 1994, 18). The length is 12.79 cm, the maximum width 4.61 cm and the maximum thickness 1.45 cm. The artefact weighs 348.08 g; the raw material was analysed in the framework of the publication (Wyss 1983, 178).

The originally conducted chemical analysis of a sample taken from the axe yielded a relatively low content of arsenic (**tabs 1-2**). This result was verified by a recent analysis carried out by the Schweizerisches Landesmuseum, which yielded an arsenic content of only 0.724 %. Ph. Lefranc et al. attribute copper of this kind to their frequently established »class 12«, which has been found in no less than 89 sites between western Switzerland and Slovakia (Lefranc et al. 2012, tab. 7).

Eich-Spiessmösli

The site is situated on the shore of Lake Sempachersee, which in 1806 was artificially lowered by 1.8 m. The site has been known since the 19th century, and is almost completely eroded today. The sole remains are numerous piles as well as prehistoric stray finds on the lake floor. The piles, which so far have not been analysed dendrochronologically, indicate buildings standing parallel to the shore.

During the 1980s a large assemblage was collected by divers, and by a local amateur. It comprises artefacts made of stone and chert and a few made of bone and antler as well. Furthermore, numerous pot sherds and two copper artefacts were discovered. The finds have so far not been analysed, but according to a preliminary sighting, the settlement phases of the Cortaillod, the Horgen and probably also the Corded Ware Cultures can be anticipated. A few finds can be attributed to the early and late Bronze Age as well.

Both copper artefacts were discovered on the lake floor and are heavily abraded, probably as a result of lying in open water during an extended period. A small triangular sheet of copper (**fig. 4, 6**) has a length of 3.02 cm, a maximum width of 2.02 cm and is 0.58 cm thick. The weight is 1.37 g, and the outline can be described as rounded-triangular. A hole could be interpreted as a remnant of a rivet hole. It is thus possible that the copper sheet is a heavily reduced remnant of a dagger. An initial XRF analysis of the surface of the piece indicates pure copper with a modest content of nickel. A subsequently conducted LA-ICP-MS analysis by the Schweizerisches Landesmuseum showed almost pure copper with only traces of arsenic (**tabs 1-2**).

The second copper piece is an elongated, trapezoidal and heavily bent sheet (**fig. 4, 5**). The unrolled length is about 7.3 cm and the maximum width 1.47 cm. The thickness is 0.13 cm and the weight is 5.00 g. The copper sheet is probably not completely preserved and it is likely that one or both ends are missing. A preliminary XRF analysis also in this case yielded pure copper with a minor content of nickel. The second artefact was subsequently analysed by LA-ICP-MS, and the purity of the copper was confirmed. It is thus conceivable that the two copper artefacts originate from the same source. It is questionable whether the object is a tool. It is more likely comparable to pendants found in the wetland site of Tettnang-Langnau »Degersee I« (Bodenseekreis) in Baden-Württemberg. However, these pieces each have a rolled end which might have served to fix the pendant on a string. The Bavarian pendants are dated to shortly after 4000 BC and thus belong to the first phase with copper in south-central Europe (Heumüller 2010, 127 ff. cat. nos 338-339). The item from Eich-Spiessmösli has no rolled end – at least not a preserved one – and none of the accompanying finds indicates a settlement phase of such an early date. At this point it is only possible to establish that we are dealing with an unknown copper artefact, which probably must be assigned to the Cortaillod Culture.

CASTING TECHNIQUE

In southeastern Europe molds of clay and sandstone (**fig. 5, 2-3**) are known from Neolithic settlements and tombs (Mayer 1977, 57 tab. 12, 168-171). Despite the large quantity of copper artefacts and casting crucibles of ceramic known from the Swiss Neolithic, comparable finds are so far missing in the region. W. Fasnacht therefore assumes that the molds could have been depressions in sand or clay (Fasnacht 1995, 186).

The site of Robenhausen (ct. Zurich) can be attributed to the Pfyn Culture, and has yielded an item which according to Ch. Strahm is likely to be seen in connection with the casting process. He suggests that an axe-like artefact made of ash wood could have been used for creating bivalve molds, and points to the

fact that almost identically formed copper axes are known (Strahm 1994, 17). If this assumption is correct, the mold can be considered as an indication of a bivalve mold made of soft material like sand or clay.

Noteworthy are casting crucibles originating from several building phases in three houses of the Pfyn Culture in the Zurich-Mozartstrasse settlement. This multi-building origin could probably indicate that the processing of copper was practiced by a few families in the settlement, and even over several generations (Bleuer 1993, 212-213).

The surface of the Horw axe was apart from the cutting edge not overworked after the casting process. This explains why seams were preserved on both narrow sides, and demonstrates casting in a bivalve mold of this artefact. But the course of the casting seams is also quite asymmetric, and the use of a mold of solid material like ceramic or stone can thus probably be excluded. What remains as an explanation is casting in sand, as this is still practiced today. Foundry sand must have been mixed with clay in order to enable shaping of the mold. Since molds are not burned like ceramics, the chance of preservation is extremely minimal, which could explain the absence of such items in the assemblages.

Vesicular protrusions, which evidently occur relatively frequently on axes of »type Kaka« (Klassen 2000, fig. 38), are interpreted as the result of a rather unsuccessful casting. As such protrusions occur on later copper objects in central Europe as well (e.g. Krause 2003, fig. 221) they may not necessarily be understood as a chronological feature.

COPPER RAW MATERIAL

The exploitation of copper outcrops in the Swiss Alps can be established from the Bronze Age and onwards (Fasnacht 1995, 184-185). The chemical analysis of Neolithic copper artefacts has been the topic of numerous studies. For example, based on metal analyses of copper objects from the European Neolithic and early Bronze Age, R. Krause defined

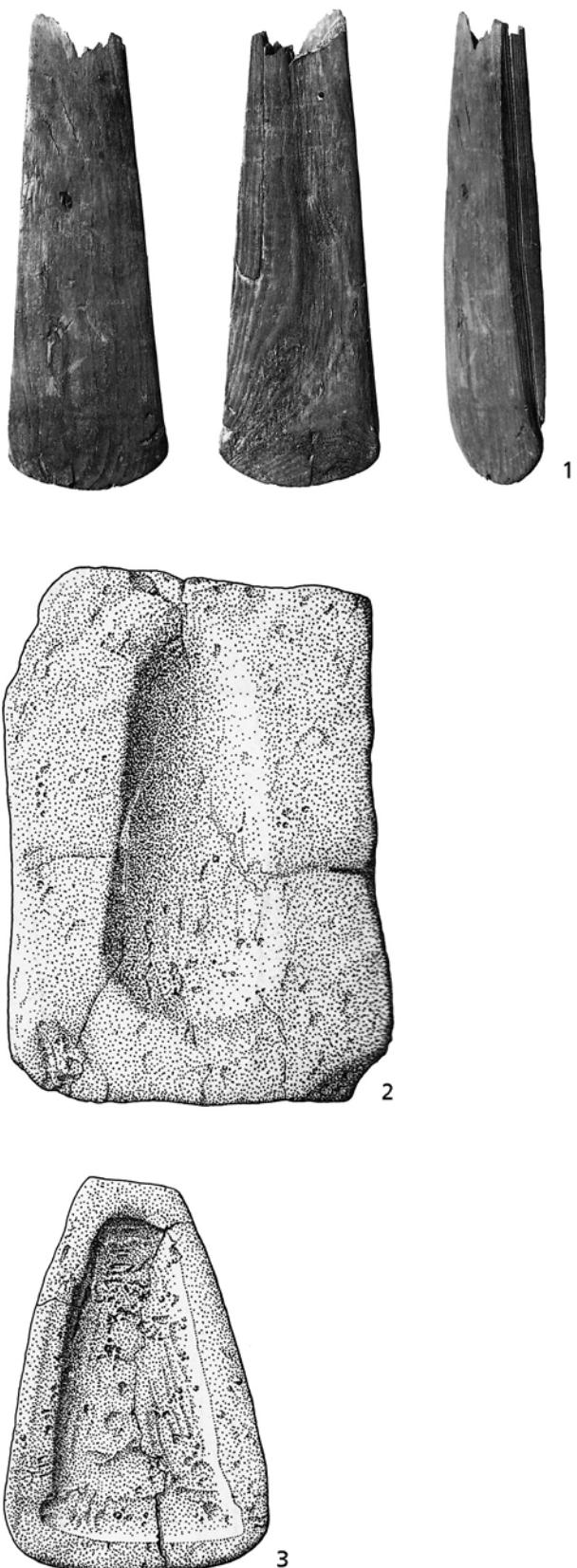


Fig. 5 Items used for Neolithic copper casting: **1** Robenhausen (ct. Zurich). Wooden artefact probably used for producing molds. – **2-3** casting crucibles from eastern Europe. – (Drawings E. H. Nielsen after Strahm 1974 and Mayer 1977). – Scale 1:2.

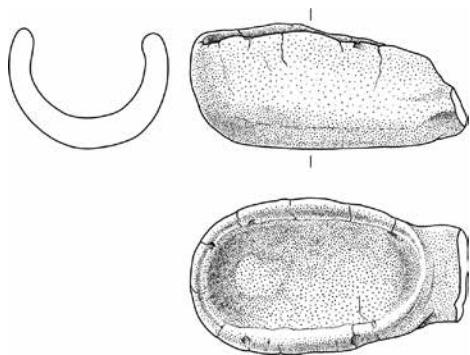


Fig. 6 Casting crucible from Hitzkirch-Seematte (ct. Lucerne). – (Drawing F. Korner). – Scale 1:2.

21 copper sorts which were divided into five main classes (Krause 2003, figs 40-41). The origin of these copper sorts, however, is still not known with certainty, and attempts to determine the sources are not undertaken in this essay. In a recent article Ph. Lefranc et al. discuss Neolithic copper sorts containing arsenic (Lefranc et al. 2012, 714). On the basis of the trace elements, 13 varieties of copper are defined. It has to be mentioned, though, that six of the varieties were defined by very few analyses. Seven varieties are assigned to the classical northern Alpine arsenic copper, the so-called Mondsee copper. Very helpful is in particular a list of central and eastern European copper artefacts used for the study.

Despite these studies we still know very little about the origin of copper varieties with or without arsenic. It is conceivable that some copper objects contain raw material from different sources. In such cases, the attempt to determine the sources would anyway hardly be feasible. Regarding this question E. Bleuer points to the fact that due to metallurgical analysis, different sources of copper could be established for the two neighbouring settlements Zurich-Mozartstrasse and Zurich-Akad/Pressehaus, both attributed to the Pfyn Culture. In the Mozartstrasse site, chalcopyrite was used as a source. Chalcopyrite is formed by corrosion and therefore contains less arsenic than the copper found in the Akad/Pressehaus settlement (Bleuer 1993, 212). If scrap metal is melted down, the mixing of different types of copper is possible, and the type of copper used can thus no longer be determined.

COPPER FINDS IN CANTON LUCERNE

Copper processing

A casting crucible made of ceramics (fig. 6) was found 1978 during underwater survey in Hitzkirch-Seematte at Lake Baldeggsee (Wey 2012, 37 note 31). The length is 150 mm, the width 86 mm and the height 67 mm. The thickness of the rim is 13 mm, and of the bottom 20 mm. The crucible is oval with a handle and is rather roughly formed. Except from the bottom, the surface is eroded, and the handle is damaged. Copper finds from the same site were already mentioned above.

Axes

The axe from Horw-Oberfondlen is likely to be compared with copper axes of the so-called type Kaka. Typologically this exemplar is clearly not of the same type as the trapezoidal axes with rectangular cross-sections and a flat butt otherwise found in the Swiss Neolithic. Based solely on typological considerations, these axes are dated to the period around 4000 BC or maybe even slightly earlier. Thus they might be significantly earlier than the beginning of copper processing in the sites of the Pfyn Culture and the adjacent areas of the Cortaillod Culture at around 3800 BC. A possible early date is supported by the absence of this type of axes in the relatively numerous settlements with copper artefacts attributed to this period.

The two remaining copper axes from Hitzkirch-Seematte (»type Thayngen«) and Egolzwil 4 (»type Kornwestheim«) correspond to the usual pieces found in the central and eastern Swiss Neolithic.

Daggers

Copper daggers are extremely rare in the Neolithic of Switzerland and in neighbouring southwest Germany as well. The dagger found in Hitzkirch-Seematte, as well as the potential dagger fragment found in Eich-Spiessmösli, were recovered during surveys and thus remain undated. They have the best typological correspondences in the southern German middle Neolithic. According to the metallurgical analysis the copper of both pieces contains no arsenic, and can thus not be attributed to the »Mondsee copper«. Therefore, the Hitzkirch dagger is likely to have another origin than the specimens from southern Germany. Chronologically both finds from Canton Lucerne are likely to belong to the classical Cortaillod Culture.

Pendants (?)

An artefact from Eich-Spiessmösli made of a copper sheet is so far unique in the Swiss Neolithic. Based on comparisons with finds from southwest Germany, the piece might be interpreted as a pendant. As it was discovered on the lake floor during an underwater survey, it remains undated, but it might be attributed to the Cortaillod Culture. There is no arsenic in the copper of this item as well, and the metal is thus no indication for the dating.

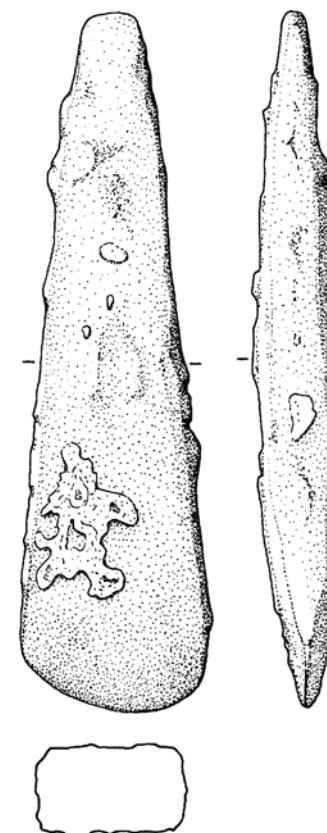


Fig. 7 Copper axe of »type Kaka« from Vantore (Region Sjælland/DK). – (After Klassen 2000). – Scale 3:4.

THE HORW AXE AND THE »EARLY COPPER PHASE« IN CENTRAL EUROPE

As already mentioned, an early phase of imported copper artefacts can be established in the Neolithic of southwest Germany. As the finds are dated to between 4300/4200 and 3900 BC, they are prior to the introduction of copper casting technology. The origin of the early artefacts has so far not been established. Copper outcrops in eastern or southeastern Europe and even northern Italy have been suggested (Klassen 2010). Due to metallurgical analysis R. Krause has proven that the early finds constitute an independent copper category with a rather high content of silver (Krause 2003, 152). Typologically the Horw axe can be compared to axes in eastern Europe and probably also northern Italy and might be attributed to the early copper phase (**figs 7-8**). But since the copper has a comparably high content of arsenic, it belongs to the eastern Alps, the so-called Mondsee copper. The metal source is therefore not the same as, for example, the »type Kaka« axe from Vantore (Region Sjælland) in Denmark (Klassen 2000, cat. no. 6), which contains no arsenic. If the typological considerations are accepted, the Horw axe is the so far earliest evidence of copper imports in Switzerland. A common origin of the early axes – and of the earliest copper artefacts at all – is not given.

CONCLUSIONS

Despite relatively few copper artefacts, the territory of the canton of Lucerne shows a remarkably richly varied range of types. Apart from the classic Neolithic axe types, a supposed early axe should be mentioned

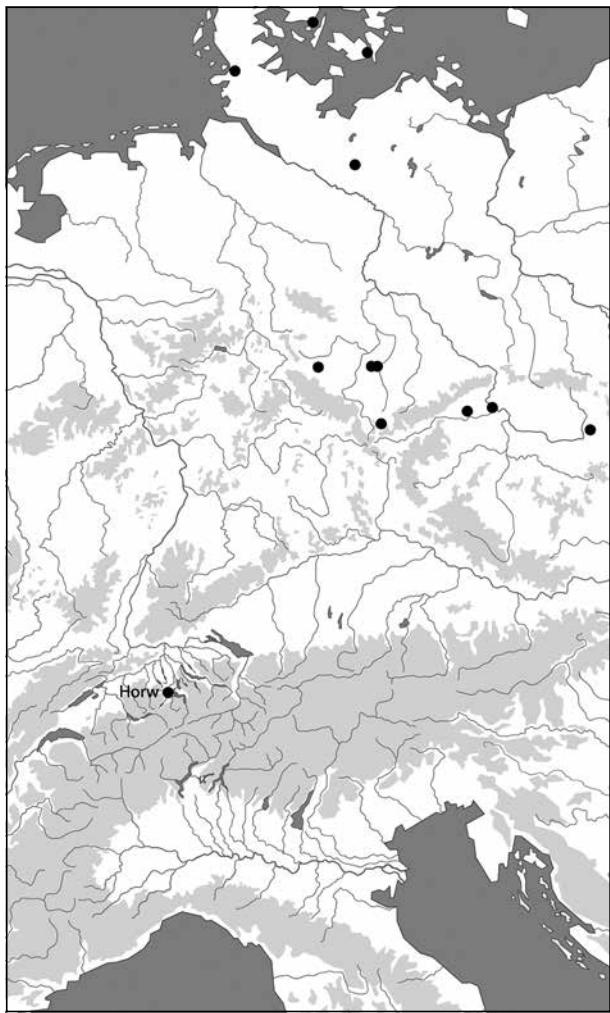


Fig. 8 Distribution of »type Kaka« axes. Mapping eastern and northern Europe by L. Klassen. – (Illustration C. Jäggi).

which has the best correlation in eastern Europe, Italy and southern Scandinavia. Metallurgical analysis indicates a different origin of the »type Kaka« axes finds compared to the Swiss axe, which is made of the so-called Mondsee copper originating from the eastern alpine region.

A completely preserved dagger is unique in Switzerland and can typologically be compared to a find from southern Germany. The copper used for the German piece can be attributed to the »Mondsee type«, which is not the case for the Swiss dagger, which hardly contains any arsenic. Again, consequently, the raw material indicates different copper sources for these artefacts. Two copper sheets, including a potential dagger fragment, were also made of arsenic-free raw material and cannot be classified.

The Lucerne copper artefacts may probably all be assigned to the Cortaillod Culture. The relevance of the various copper groups that have been defined in the literature is not always obvious and in any case often not easy to implement. The Lucerne finds apparently belong to the »pure copper« as well as »arsenic copper« categories, which are presumed to originate from eastern Europe and the eastern Alps. Late and final Neolithic copper finds from southwest France and Italy were so far not established, which can probably be explained by the low number of excavated sites from this period.

Acknowledgements

The team of the collection centre of the Schweizerisches Landesmuseum, Dr. M. Wörle-Soares, E. Hildbrand, V. Hubert, and Dr. S. van Willigen is acknowledged for their metallurgical analyses in corporation with M. Günther (Eidgenössische Technische Hochschule, Zurich). – Helpful suggestions were given in particular by Dr. Samuel van Willigen and Dr. Lutz Klassen (Museum Østjylland,

Denmark). Both gentlemen were also partners for fruitful discussions. – Mr Fritz Sager (Bundesamt für Gesundheit, Bern) carried out the XRF analysis, the first such classification of Lucerne finds. – The English text was corrected by Ole Holm Nielsen (Danmarks Tekniske Universitet).

Notes

- 1) As there is no evidence of elevated constructions in the area, »wetland« or »lakeshore sites« is used instead of »pile dwellings«.
- 2) ETH-8594: 4630 ± 60 BP.
- 3) In corporation with the Eidgenössische Technische Hochschule, Zurich.
- 4) The results of the analyses are unknown to the author.

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Zusammenfassung / Summary / Résumé

Neolithische Kupferartefakte aus dem Kanton Luzern (Zentralschweiz)

Aus dem Zentralschweizer Kanton Luzern sind sechs neolithische Kupferartefakte bekannt. Das Gebiet liegt am westlichen Rand der jungneolithischen Verbreitung der Kupfertechnologie. Zwei Beile wurden in Kulturschichten gefunden und können der klassischen Cortaillod-Kultur zugewiesen werden. Die übrigen Stücke sind ohne Kontext, gehören jedoch wahrscheinlich der gleichen Kultur an. Bemerkenswert ist ein Beil, das vermutlich um 4000 v. Chr. zu datieren ist. Somit wäre es etwas früher als der jungneolithische Kupferhorizont, der mit der Expansion der Pfyn Culture um 3800 v. Chr. in Zusammenhang steht. Ein Dolch mit Nietlöchern und ein mögliches Fragment eines weiteren Dolchs sind bis anhin einmalig im Schweizer Jungneolithikum. Vergleichbare Funde sind aus dem benachbarten Südwestdeutschland bekannt. Dasselbe gilt für einen möglichen Anhänger aus Kupferblech. Die Beile sind aus Kupfer mit einem relativ hohen Arsengehalt gefertigt, alle anderen Artefakte sind dagegen ohne Arsen.

Neolithic Copper Artefacts from the Canton of Lucerne (Central Switzerland)

Neolithic copper artefacts are known from the central Swiss canton of Lucerne. The area belongs to the western fringe of the middle Neolithic distribution of copper casting technology. Two axes were found in culture layers and can be assigned to the classical Cortaillod Culture. The remaining pieces are without archaeological context, but presumably belong to the same culture. Particularly noteworthy is an axe which probably dates back to around 4000 BC. Thus the axe would be somewhat earlier than the middle Neolithic copper horizon that is associated with the expansion of the Pfyn Culture at approx. 3800 BC. A dagger with rivet holes, and a supposed fragment of another dagger, are so far unique for the Swiss middle Neolithic. Comparable finds are known from neighbouring southwest Germany, however, as is the case for an assumed pendant made of copper sheet. The axes are all made of copper with a rather high content of arsenic, whereas all other artefacts are made of arsenic-free raw material.

Artefacts de cuivre néolithiques en provenance du canton de Lucerne (Suisse centrale)

Six artefacts de cuivre néolithiques sont connus dans le canton de Lucerne en Suisse centrale. La zone se situe à l'extrême-occidentale de la diffusion de la technologie du cuivre pour le Néolithique final. Deux haches proviennent de niveaux archéologiques et peuvent être rattachées à la culture classique de Cortaillod. Les autres pièces sont hors contexte, toutefois elles sont probablement à rattacher à cette même culture. Une hache remarquable date vraisemblablement de 4000 av. J.-C. Cette date serait donc antérieure à l'horizon du cuivre au Néolithique final qui est en relation avec l'expansion de la culture de Pfyn vers 3800 av. J.-C. Un poignard avec des trous de rivets et un possible fragment d'un autre poignard sont pour l'instant uniques dans le Néolithique final Suisse. Des pièces comparables proviennent de l'Allemagne du Sud-Ouest qui est proche. Il en va de même pour un possible pendentif en tôle de cuivre. Les haches sont composées de cuivre avec un taux d'arsenic assez élevé, tous les autres artefacts ne présentent aucune trace d'arsenic.

Traduction: L. Bernard

Schlüsselwörter / Keywords / Mots clés

Schweiz / Neolithikum / Cortaillod-Kultur / Chalkolithikum / Kupfer / frühe Metallurgie / Kulturgrenze
Switzerland / Neolithic / Cortaillod Culture / Chalcolithicum / copper / early metallurgy / cultural border
Suisse / Néolithique / culture de Cortaillod / Chalcolithique / cuivre / métallurgie précoce / frontière culturelle

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