The Geißenklösterle Flute – Discovery, Experiments, Reconstruction

Susanne Münzel/Friedrich Seeberger/Wulf Hein

ZUSAMMENFASSUNG

1973 und 1990 wurden bei archäologischen Ausgrabungen in der Geißenklösterle-Höhle in Südwestdeutschland Reste bearbeiteter Vogelknochen gefunden, die nach ihrer Zusammensetzung als Flöten erkannt wurden. Die Funde stammen aus der Schicht des „Klassischen" Aurignacien und wurden auf ein Alter von ca. 35.000 Jahren vor heute datiert. Weil die Flöten nur unvollständig erhalten sind, wurden sie mehrfach experimentell rekonstruiert, um Herstellungstechnik, Tonfolge und Spielbarkeit nachvollziehen zu können. Die Versuche ergaben, dass es möglich ist, solche kleinen Knochenflöten ohne spezielles Mundstück entweder als Schrägflöte oder sogar über die Grifflöcher selbst (da diese nicht gebohrt, sondern geschabt wurden und wie ein Aufschnitt funktionieren können) zu spielen. Die Töne sind klar und deutlich hörbar, ihre Anordnung scheint sich an einer gewissen Tonordnung zu orientieren. Dieser Fund eines der ältesten Musikinstrumente der Welt unterstreicht zusammen mit anderen spektakulären Entdeckungen aus demselben Gebiet die Bedeutung des oberen Donau-Raumes für die Entwicklung des Jungpaläolithikums in Mitteleuropa.

SUSANNE MÜNZEL

DISCOVERY: THE BONE FLUTES FROM THE GEISSENKLÖSTERLE CAVE AND THEIR ARCHAEOLOGICAL CONTEXT

One of the oldest flutes known today was found in the Geißenklösterle cave (Fig. 1, Fig. 2) in the Swabian Alb in Southwestern Germany.[1] The find comes from the 'Classic' Aurignacian layer (type fossil: points with double winged base), which was dated by ^{14}C-accelerator method (AMS)[2] to ca. 33,500 BP and with thermoluminescence (TL) to ca. 37,000 BP.[3] Excavations at Geissenklösterle started in 1973 with a sondage conducted by Eberhard Wagner (Landesdenkmalamt) and were continued from 1974 until 1991 by Joachim Hahn (Fig. 3) (University of Tübingen).[4]

The site has provided a stratigraphic sequence from at least 43,000 up to 10,000 BP (Tab. 1). The deepest known layer contains finds from the Middle Palaeolithic, usually associated with Neanderthal man. Above lies an Early Aurignacian layer (^{14}C AMS date ca. 38,400 BP and Electron Spin Resonance [ESR] date ca. 40,200 BP), followed by the 'Classic' Aurignacian with a large area of bone ash which provided four carved ivory figurines depicting human, mammoth, (cave)bear and bison, a limestone pebble painted in three colours, as well as ivory beads, perforated and dyed fish vertebrae and ornamented objects of antler and ivory.[5] The art objects from the Aurignacian of the Geißenklösterle are from the same period as the famous finds of mobile art from caves in Southwestern Germany such as the ivory figurine of a horse from the Vogelherd and the human figurine with the head of a lion from the Hohlenstein-Stadel in the Lone Valley (Fig 4).[6] At the beginning of the Upper Palaeolithic, 'modern man', *Homo sapiens sapiens* appears in Middle Europe, and at this time the origins of art and music are clearly taking shape.

The horizon lying above contains a Gravettian occupation in several living floors (^{14}C AMS date ca. 29,000 BP), while there is only one fireplace preserved from the Magdalenian in the Geißenklösterle (^{14}C AMS date ca. 13,000 BP). After the

1 Hahn/Münzel 1995.
2 Richter et al. 2000.
3 AMS = Accelerator Mass Spectrometer, TL = Thermoluminescence Method, BP = Before Present (1950).
4 Hahn 1988.
5 Hahn 1988.
6 Hahn 1986.

Gravettian occupation, sterile layers suggest a possible hiatus in the occupation of Southwestern Germany probably caused by the Last Glacial Maximum.

In the faunal assemblage cave bear which hibernated in the Geißenklösterle cave is the predominant species in the entire sequence. Geissenklösterle provided a wide and diverse faunal spectrum, and the layers before the glacial maximum around 20,000 BP can be classified as a 'Mammoth Steppe Environment'. In addition to species of the arctic tundra like reindeer, arctic fox and arctic hare, the grass steppe environment is represented by mammoth, wild horse and woolly rhino. Red deer is associated with reindeer similar to parts of Scandinavia today. Mountainous elements like ibex, chamois and marmot are also present in the Swabian Alb. Carnivores are not very characteristic for specific biotopes, but they survive as long as prey is present. The presence of a large number of carnivore species also reflects a diverse and broad variety of prey species.

Regarding the seasonal occupation of the Geissenklösterle which can be evaluated by determinating the age of the young prey animals, the palaeolithic hunter-gatherers occupied the cave during the winter season, as shown by the age of a hunted foal and by fetal bones of horse, and in the spring, as shown by the remains of hunted mammoth calves.

The Ach Valley must have been attractive during the winter because of wild horse spending this time of the year in the protected Swabian Alb valleys, and in spring for the mammoth herds having their calving ground nearby.

The evaluation of the fauna within the scope of a project of the 'Deutsche Forschungsgemeinschaft' (DFG) was recently finished by the author.[7] During the process of faunal analysis, broken bird bones were found in a sample of water sieved sediments from the excavation. These fragments showed holes, cut marks and striations. After refitting the pieces, one sample came out as a flute with at least three holes (Fig. 5a,c). The first step of the production of the flute was smoothing the surface of the bone with a flint tool.[8] Then the proximal end of the bone was cut off by a circular groove, while the other end unfortunately remained incomplete, even after carefully searching through the surrounding finds recovered by collecting and wet sieving. A few additional fragments with notches and a partial hole from the first excavation (1973) were recognized as belonging to another flute (Fig. 5b).

The so-called flute 1 is made out of a swan's radius, probably a Whooper Swan (*Cygnus cygnus*, determination by P. Krönneck).[9] The flute is the only indication of Whooper Swan in the bird remains of the Geißenklösterle. This probably means that the flute was not manufactured in the cave but was brought in as a finished product.

The maximum preserved length of flute 1 is 126.5 mm, the possible length compared to the total length of a swans radius could have been 180 to 200 mm. The asymmetrical diameter of the flute is 10.3 x 9.1 mm.

FRIEDRICH SEEBERGER

EXPERIMENTS: THE WAY OF PLAYING

Experiments in playing were carried out with replications (Fig. 6) of the Geißenklösterle flute 1.[10] The source material was radius bones from Mute Swan (*Cygnus olor*). Flint tools were used for the removal of the joint ends and for cutting the holes. The replications have a length of 150 mm, and are blown from the end which is broken on the original as a bevelled flute.

The bevelled flute is considered the precursor of the transverse flute. It is very well known today in the Mediterranian as Flûte oblique, Flojéra, Fujara or Awada. Very old bevelled flutes are exhibited for example at the Cairo Museum and the Kantonal Museum in Lausanne.[11] A bevelled flute is blown in an inclined downward position, as if one wants to whistle (way of playing, s. Fig. 7).

On replications of the Geißenklösterle flute 1 the tones c^3, d^3, f^3, b^3 and c^4, d^4, f^4 can be played by this way of blowing at it. The tones sound loud and clear (c.f. our CD). The pitch and the timbre do not change when the holes are transferred from the concave side to the convex side of the bone. The replications are playable to a minimal inside diameter of the bone tube down to 4.3 mm. Bevelling the edge of the blown-at end of the bone will improve the playability, although there is no real need for bevelling.

The replication of a flute from the Isturitz cave, having a straight edge, could be blown instantly that way.[12]

7 Münzel 1994; Münzel 1997; Münzel 1999.
8 For use and handling of flint tools to make flutes see Einwögerer and Käfer, this volume.
9 Unpublished manuscript concerning the bird fauna at the Geißenklösterle.
10 Seeberger 1998; Seeberger 1999.
11 Meylan 1992.
12 Replica by G. Lawson, Cambridge.

CONCLUSION

The bevelled flute is easier to manufacture than any other kind of flute. This fact and its nice, flexible sound are reasons for its popularity with herdsmen and nomads. Its use can be traced back 5,000 years.

The pitch of the tones is influenced by the position of the lips and the tongue and the whole tonal scale is only possible if one finds the position suitable for it. Therefore, already at a very early time, possibilities were sought for to produce tones more easily. Examples may be the pan flute, the vessel flute, the bevelled flute, the recorder and the transverse flute.

For generating tones with a high pitch, a tube is suitable with a narrow diameter like the Geissenklösterle flute. Such a tiny instrument can be played best as a bevelled flute. The flute from the Geißenklösterle, being the oldest flute found, stands at the beginning of the development of flutes. It is very likely that it was blown as a bevelled flute without any mouthpiece. The invention of the bevelled flute might be associated with the perception of tones caused by the wind on unworked bone tubes.

While discussing how the mouthpiece of palaeolithic bird bones with fingerholes could have looked, it was speculated that they might have been reed instruments. Simple reed instruments are built by a cut behind the valve of a reed (Fig. 8). This way a lamella is produced which swings and creates a sound if this end is taken into the mouth and blown. This technical complicated type of instrument must have been created independantly of the development of the flute.

WULF HEIN/SUSANNE MÜNZEL

RECONSTRUCTION: SOUND PRODUCTION AND SOUND QUALITY EXPERIMENTAL RECONSTRUCTION AND ADDITIONAL CONSIDERATIONS

Because the original of flute 1 was only fragmentarily preserved, an experimental reconstruction was necessary to understand the technique of production and to learn about function and sequence of notes and playability, a procedure that was recognized as being important for the archaeology of music several years ago.[13] Some of the experiments were carried out by the excavator J. Hahn and by one of the authors (W.H.),[14] which showed that the reconstruction can be played without any special mouthpiece by simply blowing into one end as into a blowpipe (Fig. 9).[15] The tones are generated at the fingerholes themselves, because these holes are not drilled in vertically, but cut or scraped in horizontally, so that the sharp edges of the fingerholes work like an aperture. With this way of playing, the following frequencies are at the players' disposal (given in Hz with lower and upper limits, because the tones can be changed up to 100 cent depending on the blowing pressure): a^3 ~ 1760, b^3 ~ 1980–2090, c^4 ~ 2090–2220, e^4 ~ 2640–2790, f^4 ~ 2790. The tones sound relatively clear, but not very loud. Whether the original produced the same tones cannot be solved, because its fragmentary preservation status does not reveal the original length or the existence of further holes. Although it is possible to generate tones by the fingerholes, this method should not be generally predicted for all palaeolithic bone flutes. Using it as a bevelled flute, as F. Seeberger suggests, may be more plausible. It is conceivable that the Geissenklösterle flute had predecessors made of reed, no matter how they looked, which perhaps were also played as bevelled flutes.

Looking however at the tones generated by the replica, they do not sound aimless or accidential, but seem to be oriented in a certain tonal order, a fact that was also observed by the researchers of the bone flutes from the Early Neolithic site Jiahu in Henan Province/China.[16] Here also the counterargument does not take effect, that there cannot be made any statement about the real tones, because replications, however carefully they are made, never correspond to the original. These Chinese flutes are completely preserved and obviously as playable as they were more than 8,000 years ago. The tones of the Geißenklösterle flute seem to be in systematic distances to each other, and allow the presumption that they did not come about accidentally by piercing the bone at random, but are in intentional proportion similar to what we are accustomed to hear, even if the tones experimentally generated can be changed by the blowing pressure.

The common point of view that the notches cut in the flute could have functioned in addition as a 'washboard' instrument to produce rhythmic sounds is not shared by the authors. On one hand the instrument is too tiny to play on and scrape at the same time. On the other hand the notches are

13 Schneider 1973.

14 Hahn/Hein 1995; Hein/Hahn 1998; Hein 1998.

15 The Geißenklösterle flute can be held and played in different ways (see Fig. 7 and 9). The difference of the results referring to the sound are still to be examined, the tonal differences are the same.

16 Zhang et al. 1999; see also their contribution to this volume.

not deep enough to produce sounds and there are no traces of use-wear. In all probability the notches were carved for ornamental reasons, a usual technique observed on many objects from the Aurignacian. It would be interesting to examine further the notches microscopically in order to find out whether they were carved with one or several different tools, a method used by F. d'Errico to examine the flute finds from the Isturitz cave.[17] Such an examination, particularly considering comparative traces already experimentally produced in Bordeaux and Cambridge, might add a temporal dimension to the find, if it could be verified, that the notches were carved one after the other with different tools. An international and interdisciplinary research project might open up a rare opportunity in archaeology to catch a glimpse of the spiritual 'superstructure' of the Upper Palaeolithic beyond the horizon of the material goods of our ancestors. It would provide a look at the immaterial world of a period currently of interest to both science and the media because of the replacement of the Neanderthal man by the modern *Homo sapiens sapiens*.

This flute find, together with the recently discovered painted stone[18] and the horse head made of ivory[19] from the Hohle Fels, a cave situated nearby in the Ach Valley, emphasizes the role of the Upper Danube Area in the Central European Upper Palaeolithic.

DEDICATION

We dedicate this paper to the excavator of the Geißenklösterle flute, Prof. Joachim Hahn, who died in April 1997 much too early and who could not finish his work in the Ach Valley.

17 Oral communication d'Errico/Lawson; see also their contribution to this volume.
18 Conard/Floss 1999.
19 Conard/Floss 2000.

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Fig. 1 Bruckfelsen with Geißenklösterle (right).

Fig. 2 Abri/cave Geißenklösterle.

Fig. 3 Excavation of the cave directed by Joachim Hahn, 1975.

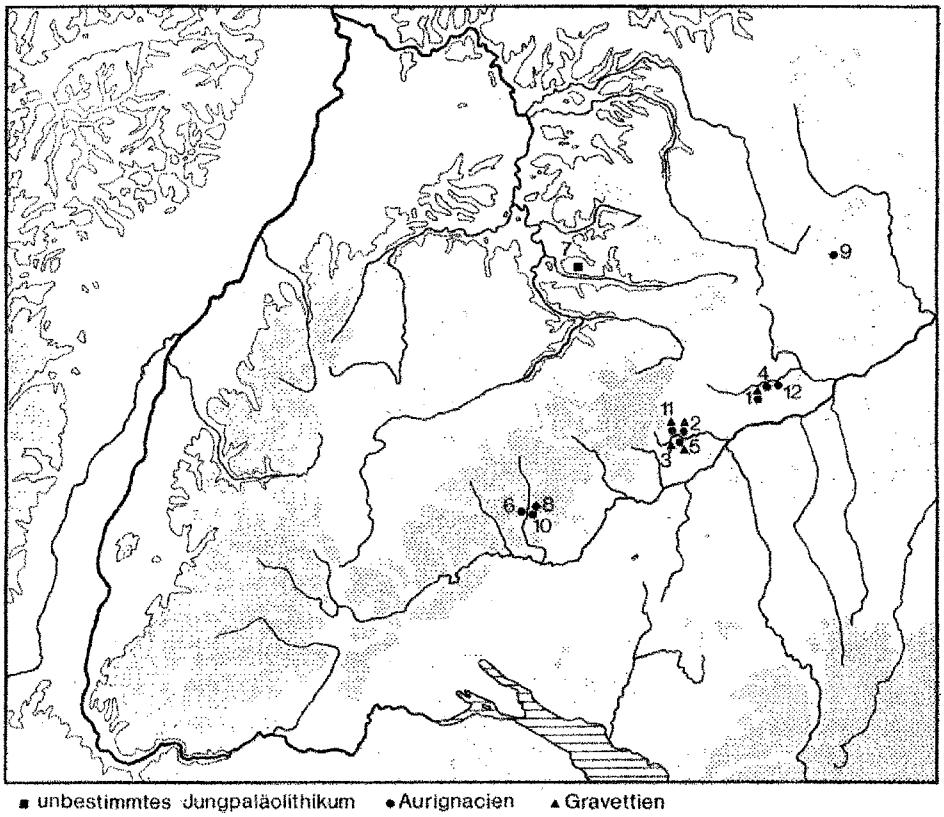

Fig. 4 Map with Geißenklösterle location and other caves. 1 Bocksteinhöhle/Bockstein-Törle, 2 Brillenhöhle, 3 Hoher Fels, 4 Hohlenstein Stadel/Hohlenstein-Bärenhöhle, 5 Geißenklösterle, 6 Göpfelsteinhöhle, 7 Korb Kleinheppach, 8 Nikolaushöhle, 9 Große Ofnet/Kleine Ofnet, 10 Schafstall, 11 Sirgenstein, 12 Vogelherd.

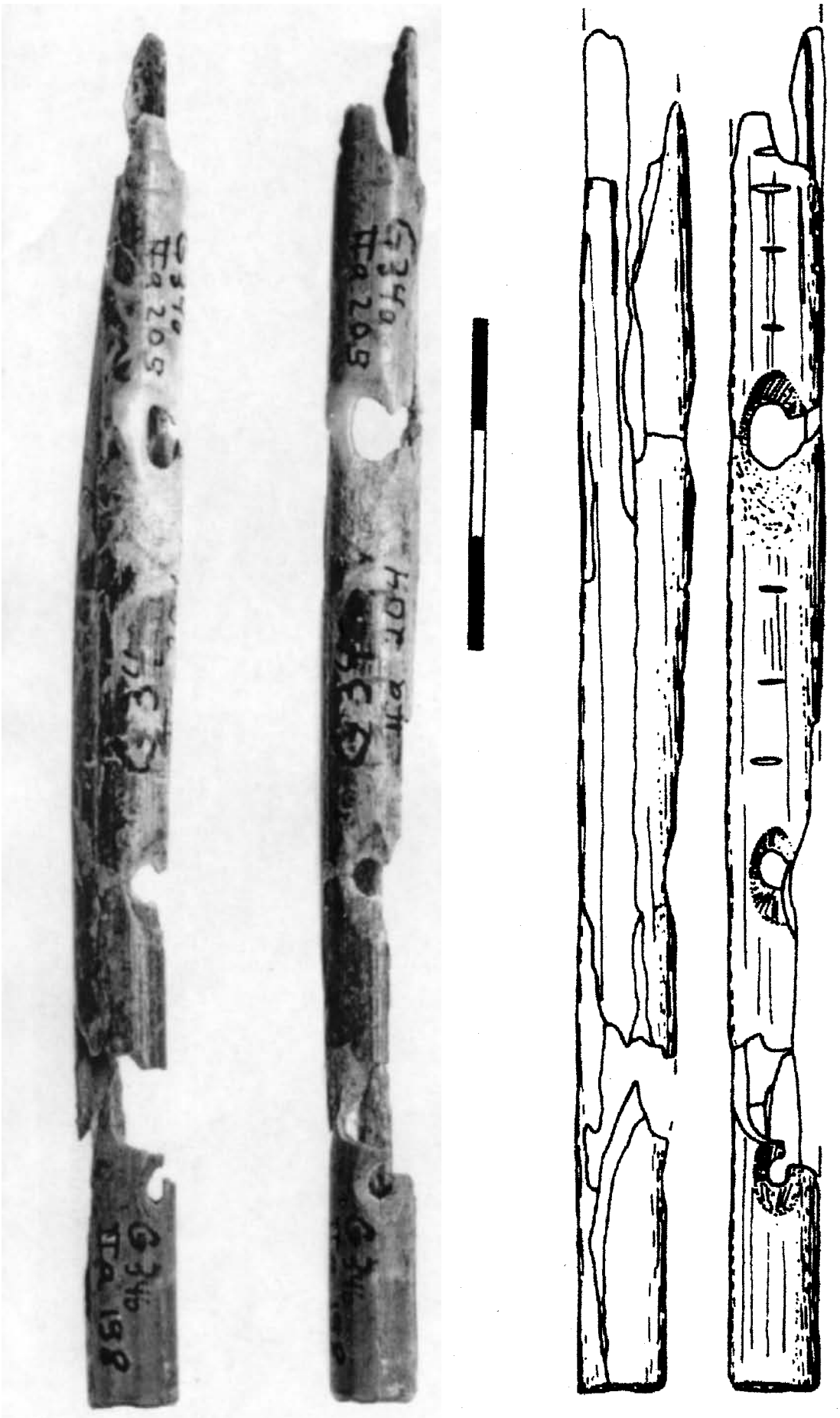

Fig. 5 a Flute 1 from Geißenklösterle cave (not yet completed with wax). Photograph: Hilde Jensen (Institut für Urgeschichte Tübingen)
Drawing: Clemens Pasda. Mounted by Wulf Hein.

Fig. 5 b Fragments of flute 2. Photograph: Hilde Jensen.

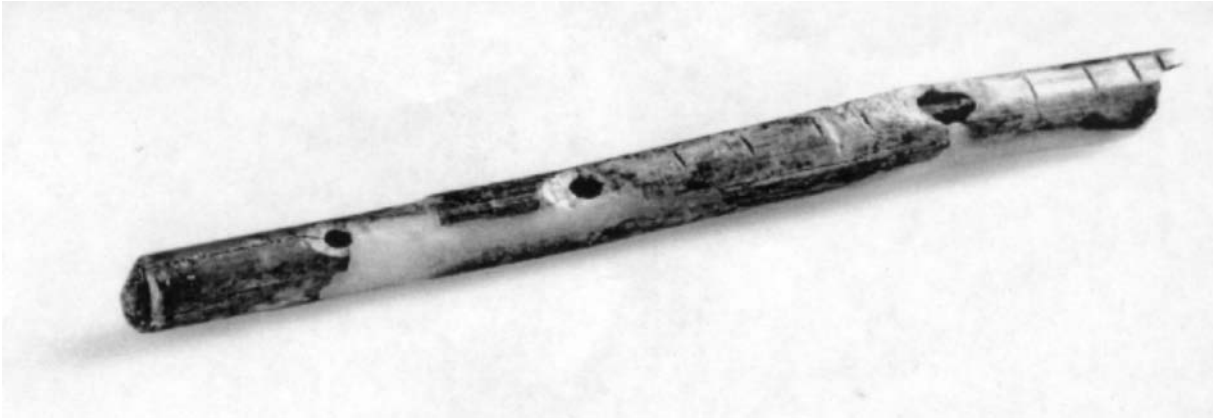

Fig. 5 c Flute 1 from Geißenklösterle completed with wax. Photograph: Hilde Jensen.

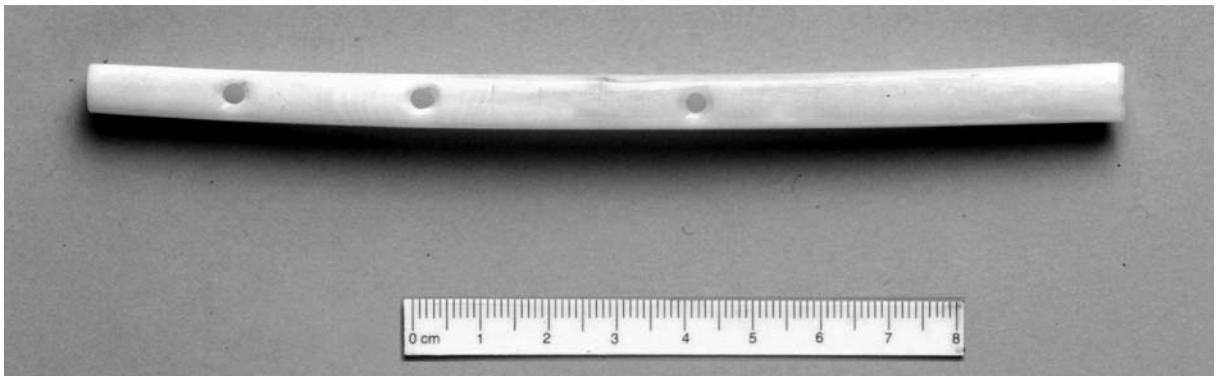

Fig. 6 Replication of the Geißenklösterle flute 1. Photograph: Frankenstein/Zwietasch (Württembergisches Landesmuseum Stuttgart).

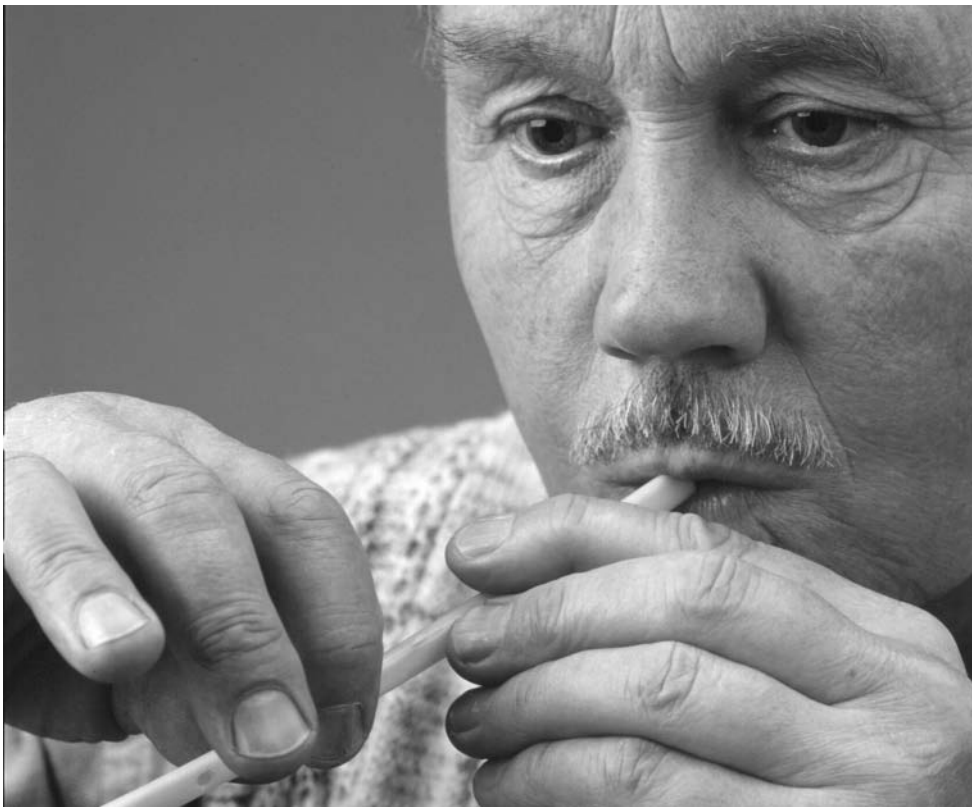

Fig. 7 Playing a replication of the Geißenklösterle flute 1 as bevelled flute. Photograph: Frankenstein/Zwietasch.

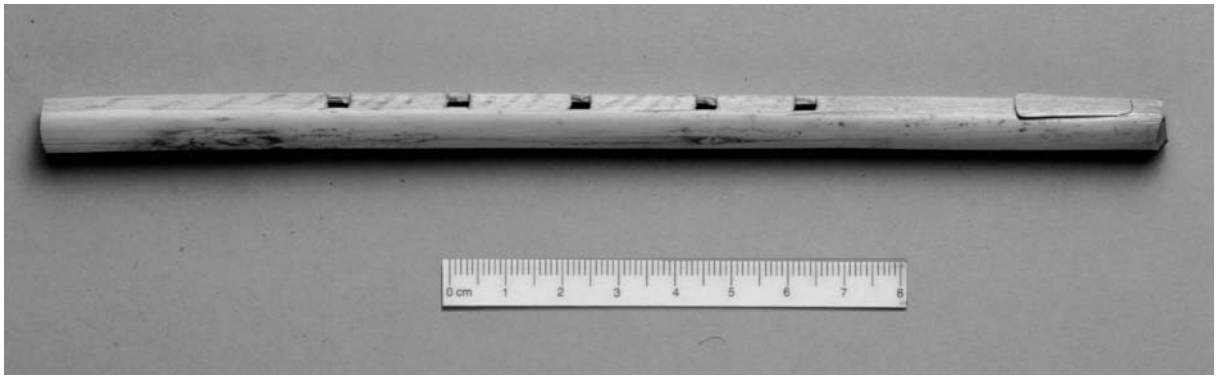

Fig. 8 Simple Greek reed instrument made from cane. Photograph: Frankenstein/Zwietasch.

Fig. 9 Playing a replication of the Geißenklösterle flute 1 over the fingerholes. Photograph: Wulf Hein.

Archaeo-logical Horizon	Geo-logical Horizon	Technocomplex	Structures	Special Finds	^{14}C-AMS-,TL- and ESR-data B.P.	
AH 0-In	GH 0-1	Mixed finds from the Middle Ages, the Iron Ages and the Mesolithic			^{14}C-AMS ~ 13 000	**Upper Palaeolithic Homo sapiens sapiens**
AH Io	GH 2	**Magdalenian** (only a few archaeological finds)	fireplace			
	GH 3/4	No archaoelogical finds				
	GH 5	Stratigraphically not assigned, controversal radiocarbon data				
AH I	GH 6-10	**Gravettian**	two fireplaces	Ivory pendants, teeth pendants	^{14}C-AMS-data 27 000-29 000	
	GH 10/11	Horizon with cryoturbation				
AH II	GH 12-13	**‚Classic' Aurignacian** (type fossil: bone points with double winged base)	Large hearth area with burnt bones	**Flute 1 + 2** Ivory figurines, painted pebble, ivory pendants	^{14}C-AMS ~ 33 500 TL ~ 37 000	
AH III	GH 14-16	**Early Aurignacian**	One small fireplace with an intensive ivory working area	Ivory lances, intensive ivory industry	^{14}C-AMS ~ 38 400 ESR ~ 40 200	
	GH 17	No archaeological finds				
AH IV	GH 18-19	**Middle Palaeolithic**			ESR-data 43 000 ± 4 000	**Middle Palaeolithic Homo sapiens neanderthal.**

Tab. 1 Stratigraphy and archaeology in the Geißenklösterle cave.