Ancient and Modern Bone Artefacts from America to Russia

Cultural, technological and functional signature

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Highland Tunes in the Lowlands:
a Medieval Vulture Bone Flute from Northern Germany

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Abstract

A recent find of a medieval bone flute manufactured from a vulture ulna is presented. It was found at the site of the castle in the North German town of Vechta. Discrepancies between species identification, typology and find location are discussed.

Introduction, archaeological context and historical background

In this report a medieval bird bone flute from Northern Germany will be presented. It is an outstanding artefact in itself and, additionally, it possesses several peculiar features and circumstances. The flute was found during a rescue excavation in the summer of 2005 at the site of the medieval castle of Vechta, a county capitol in the north of the federal state of Niedersachsen (cf. Figure 2). It was retrieved by hand sorting of the filling material from the castle's defence ditch. The flute was broken into two pieces that could be reassembled. The two pieces were not found associated with each other; instead different persons at different spots on different days excavated them.

The castle of Vechta was mentioned in historic documents for the first time in 1221, the surrounding village in 1188. However, according to historic sources Vechta was probably founded as early as 1080 by Bishop Benno 2nd of Osnabrück in the course of the construction of the so-called *Rheinische Straße*, an important merchant's route between the cities Osnabrück and Bremen. Its location at a ford explains Vechta's strategic importance for military as well as toll collecting purposes. The architecture of the castle was a simple circular structure surrounded by a ditch with two door houses (Figure 1a-b). The flute was found next to one of these (Figure 1). The castle was demolished between 1689 and 1698, when it was replaced by a state of the art citadel fortification. Although there were times when the castle was inhabited by members of the high nobility – *e.g*. from 1248 to 1251 by Jutta von Ravensberg, a close relative of the Staufer king Friedrich 1st – it was never one of the major noble courts in the region. Nevertheless Vechta was a wealthy merchant's town until the 15th century (Fahl-Dreger 2005; pers. com. 4-5/2008). The city of Vechta is situated at an altitude of 37m above sea level about 90km from the North Sea coast in a flat marshy area dominated by extended peat bogs.

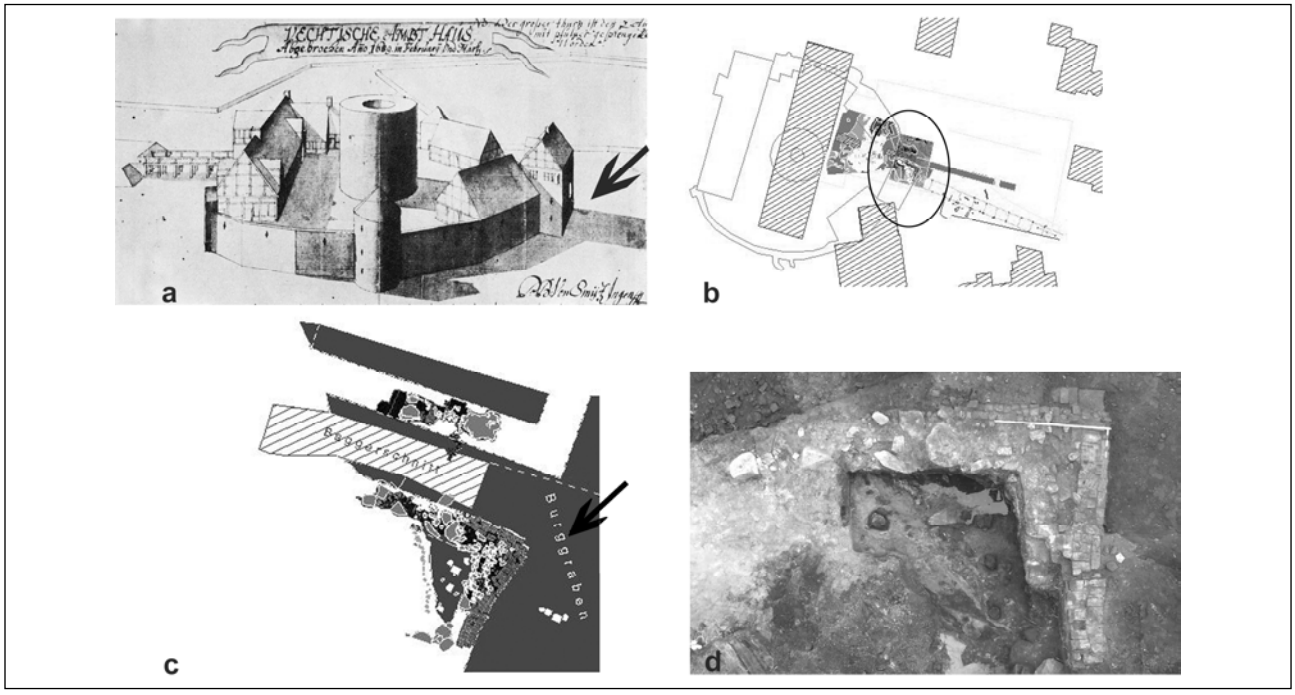

Figure 1: ***a)*** *Drawing of the Vechta castle by P. B. von Smytz (between 1683 and 1689);* ***b)*** *archaeological site plan;* ***c)*** *detail of site plan with door house area;* ***d)*** *door house foundations. Arrows indicate the approximate location of the flute find (plan and photo: M. Wesemann).*

Finds from the site include large amounts of pottery sherds, animal bones, metal and glass objects. The pottery was dated mainly to the 14th century; a few pieces date back to the 11th century (Fahl-Dreger, pers. com. 3/2007). Due to the coarse methods applied in the rescue excavation no detailed stratigraphic information is available. The bone material consists of 995 fragments, 706 of which could be identified to the species level. The species represented comprise the common spectrum of medieval domesticates (cattle, pig, sheep, goat, dog, hen, cat, goose, duck, dove in order of abundance) plus a few bones of wild mammals and birds (roe deer, hare, squirrel, mole, crow). Apart from the flute two pieces of handles made from red deer antler are the only worked bone objects found (Mahlitz-Frey 2006).

Bone flutes are principally not uncommon objects in medieval North German contexts. Usually they were manufactured from tibiae of sheep (*Ovis aries*) and goat (*Capra hircus*)[1]. Less common are flutes made of bird bones. Local medieval bird bone flutes were mainly made from goose bones (*Anser* sp.), with exceptional specimens from swan (*Cygnus* sp.), eagle (Accipitridae) or heron (*Ardea* sp.) (cf. Table 2). In most cases ulnae were employed (Brade 1975; 1978; Tamboer 1999, 10-11; Ulbricht 1984, 40-41, 61-62, pl. 44).

Figure 2: Map showing the location of Vechta (black) in relation to the geographic distribution of the griffon vulture (Gyps fulvus) (dark grey). http://upload.wikimedia.org/wikipedia/commons/8/83/Gyps_fulvus_dis.PNG).

Archaeozoology

The archaeozoological identification of the flute from Vechta was accomplished morphologically with the aid of the osteological reference collections of the Archäologisch-Zoologische Arbeitsgruppe Schleswig-Kiel (AZA), Archäologisches Landesmuseum Schleswig, the Vogelsammlung (bird collection) of the Naturhistorisches Museum Wien (NMW VS/Sk) and the Labóratorio de Arqueozoologia, Instituto Português de Arqueologia (CIPA), Lisboa. For anatomical terminology Nickel *et al.* (2004) is applied.

The bone could readily be assigned to a bird by its structure and morphology. The epiphyses are missing but the shape of the cross sections and the localisation of the vascular channel (foramen nutricium, Figure 3b-c) identify it as a right ulna. The remaining length of the bone is 266.9mm; some additional anatomical measurements are given in figure 3b. Species identification, however, turned out to be an unexpectedly complicated task. Identification difficulties were mainly due to some extraordinary features of the bone: the complete lack of quill knobs (papillae remigiales caudales) and its extraordinarily straight shape (in contrast to most bird ulnae which show at least a slight convex curvature of the caudal side). These features are due to the fact that the bird was juvenile. Quill knobs are the insertion points of the wing feathers and develop in reaction to muscle activity during flight. Also typical for juvenile bird bones are the rough texture of the bone surface (Figure 3) as well as the relatively large diameter of the foramen nutricium, which becomes narrower in adult birds (Figure 3b-c). Comparisons covered most large bird species (cranes, pelicans, storks, herons, swans, birds of prey, albatross, great bustard, eagle owl) before the bone could finally be assigned with confidence to a vulture (sub-family Aegypiinae). The length of the bone limits the range to two species, the griffon Vulture (*Gyps fulvus*) and the black vulture (*Aegypius monachus*). Discrimination of the two species would be possible using the morphological features of the epiphyses (Moreno-Garcia and Pimenta 2004; Moreno-Garcia *et al.* 2005, 342-346), but these were removed by the craftsman. The same authors also give criteria for the separation of both species using the localisation of the foramen nutricium. In *Gyps* the foramen tends to be located more towards the proximal end of the ulna than in *Aegypius*. Compared to complete ulnae, approximately 13 - 15mm are missing to the defined measuring point at the proximal flute end (Figure 3b-c), resulting in an estimated value for the distance between the foramen nutricium and the proximal epiphysis (FP) of 91 - 93mm. This value is below the observed range of *Aegypius* and within the range of *Gyps*, therefore the bone belonged most probably to a Griffon vulture.

The identification of a vulture is surprising since the North German lowlands have no vulture habitats and never had in historic times. Griffon and black vultures prefer mountainous habitats for breeding. Seacoasts and wetlands are not favoured. The present day European residential distribution of both vulture species includes the Iberian and Balkan Peninsulas, Southern France, Italy, Romania, Hungary and several Mediterranean islands (cf. Figure 2). Additionally historical distribution of the griffon vulture is known for 19th century Austria and for the Schwäbische Alb in Bavaria, Germany up to the 18th century. In the 13th century Albertus Magnus noted griffon vultures nesting in the German mountains of Hunsrück, Hochwald and Donnersberg today in the

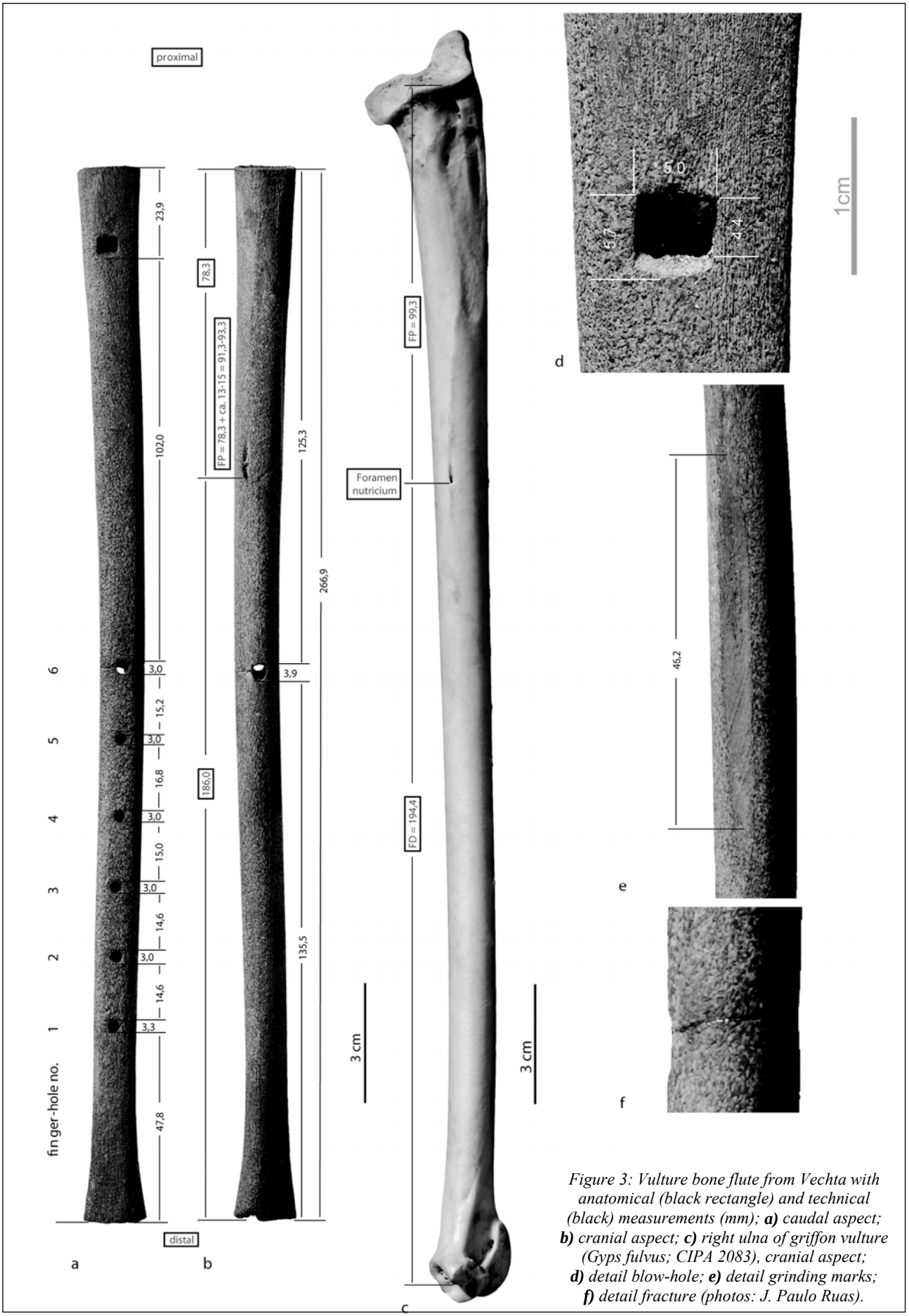

Figure 3: Vulture bone flute from Vechta with anatomical (black rectangle) and technical (black) measurements (mm); ***a)*** *caudal aspect;* ***b)*** *cranial aspect;* ***c)*** *right ulna of griffon vulture (Gyps fulvus; CIPA 2083), cranial aspect;* ***d)*** *detail blow-hole;* ***e)*** *detail grinding marks;* ***f)*** *detail fracture (photos: J. Paulo Ruas).*

federal state of Rheinland-Pfalz. Griffons recently resettled in the Austrian Alps. The black vulture is less common than the griffon and its distribution is declining. While griffons are gregarious and often breed in colonies the black vulture is more solitary. Both vulture species are long distance flyers and immature (1 – 6 year old) birds, in particular, migrate far from their breeding places[2]. They also appear frequently north of their breeding range. There are records of both species from England, Netherlands, Denmark, Germany, Estonia, Latvia and Finland (Bouchner 1976, 38, 40; Brohmer 1995, 473; Cramp and Simmons 1980, 73-75, 89-91; Fischer 1976, 383-388; Heinzel *et al*. 1972, 84). To conclude: although it is not completely impossible to see a vulture in Northern Germany, this is not their preferred region and the evidence of a juvenile individual places the origin of the bone in the vicinity of a breeding situation. Therefore the catch of a wild juvenile vulture in Vechta is extremely unlikely. The approximate distances from Vechta to the nearest historic and actual breeding areas are 300km to the Hunsrück, 450km to the Schwäbische Alb, 700km to the Alps and more than 1200km to the Pyrenees.

As the length of the bone is approximately like that of an adult the vulture must have been a subadult but cannot have had much flight experience. Both species are fledged within 100 to 130 days (Bouchner 1976, 38, 40; Cramp and Simmons 1980, 79, 94) and therefore the bird was probably around this age when it died or was killed. As the hatching of nestlings begins in April, death probably occurred in late summer (August to October).

Artefact morphology and taphonomy

The ulna has been cut at the proximal and distal ends right above the epiphyses, perpendicular to the bone axis (Figure 3a-b). The cut shows a very regular plane and was most probably performed with a saw. On the distal half of the caudal side of the bone six finger-holes were applied, all of which are circular with a diameter of ca. 3.0mm and have certainly been drilled (Figure 3a). While holes n°1 – 2 and 4 – 6 are set in a straight line, hole n°3 is slightly offset to the ventral side of the bone respectively the right side of the flute (Figure 3a). Hole n°6 is opposed by a thumb-hole on the cranial side (Figure 3b). The perimeter of the cranial hole is not exactly circular; it has a slight oval shape of 3.0 x 3.9mm. There is a straight axis through both holes, which is not exactly perpendicular to the axis of the bone; instead it runs in a slight angle from cranio-distal to proximo-caudal. These features suggest that both holes were drilled in one action beginning from the cranial side. Situated near the proximal end is a square opening of 5.0 x 4.4mm side length used as blow-hole. Its distal side has an oblique bevelled shape used as labium (Figure 3d). For technical measurements of the flute see figure 3.

Apart from drilling and cutting traces there are grinding marks on the cranio-ventral edge of the proximal third of the bone (Figure 3e). Finally the breakage in the middle of the bone (Figure 3f) has to be discussed. The edges of the fracture are of the same colour as the surface of the flute. Since two different people found the pieces on different occasions, a fracture during recovery can be excluded. So far it is most likely that the fracture is an historic event after which the flute was discarded into the defence ditch. The fracture line runs through the two opposed holes, obviously the weakest point of the object. Therefore the question remains whether or not the fracture might have occurred during manufacture. If this were the case, it must have happened while drilling the very last existing hole (as it seems illogical to continue work on a broken object). This is unlikely, as both holes are finished and of a regular shape. If an object breaks during drilling it would break at the moment pressure is applied by the drill, leaving an unfinished drill hole, and not after the drill has completely penetrated the substantia compacta and the pressure is released.

Preliminary typological and cultural assessment

A detailed typological and acoustic analysis will have to be performed by scholars skilled in musical archaeology and musical science. Nevertheless some preliminary hypotheses can already be laid out here.

Raw material selection

As already pointed out in the introduction, the vast majority of local bone flutes were made from ovicaprid tibiae and even among the examples of bird bone flutes, the large species are rare finds. There are no vulture bone flutes known from the archaeological record of Germany, and with the exception of two Roman finds from Nijmegen, Netherlands (cf. Table 1-4, 1-5) there are none from any other North European country[3]. In contrast several flutes made from vulture bones are recorded from the Mediterranean region. So far there are 19 published specimens from France, twelve from Spain, two from Portugal and one each from Austria and Syria (Table 1)[4].
A question to be addressed is why this specific bone might have been chosen as a raw material by the craftsman. This may comprise functional reasons, availability or a deliberate choice related to some overlying cultural consideration. Numerous examples show that ulnae, radii and tibiotarsi of large birds like eagles, vultures, swans, storks, cranes or flamingos are suitable blanks for flutes, from the Palaeolithic until today[5]. We may assume therefore that the bones of large birds living in the vicinity of the site may have been chosen primarily for functional reasons (Table 2). A look at the zoogeographical and archaeozoological context, however, reveals that Vechta is neither a vulture habitat nor does the assemblage contain bones of vultures or any other bird of prey. The question of easy availability of vulture bones therefore can be negated. It is notable that

large birds of prey do have a specific meaning in various cultures, often related to status, prestige, magical or ritual beliefs. Powers assigned to an animal are believed to be transferred to the person dealing with parts of the animal. For a compilation about the historic relationship between man and vulture see Becker (2005, 334). Therefore a deliberate choice of a vulture bone as raw material for some deeper reason seems not completely unlikely.

Functional considerations

In order to produce a melodic tune, the air column in the corpus of a flute has to be set into vibration. There are four principal methods known to generate this vibration. In reed flutes a reed inserted in the upper end of the flute is set into vibration by the blower. Flutes of the Arabian *nay*-type have an oblique proximal edge over which the air-stream is divided. Transverse flutes have a closed upper end and the vibration is generated by blowing directly over the edge of a blow-hole situated in the proximal third of the flute. In duct flutes a block with a channel inside is inserted in the upper end through which the air is led onto the edge (labium) of a blow-hole.

Table 1-6 to 1-9 and table 2 display features of comparative finds of medieval large bird bone flutes. To shed light on the question how the specimen from Vechta fits into the context of other contemporary flutes it is useful to widen the perspective on bone flutes in general[6]. In her elaborate work on medieval Middle and Northern European duct flutes Brade (1975) analysed 120 bone flutes from Belgium, Denmark, Germany, Netherlands, Norway and Sweden. Although several new finds have emerged since 1975, the general typological picture remains the same. The predominant size range of medieval Northern and Middle European flutes is 130 – 180mm; larger examples are rare and none exceed 240mm. This fact is related to the predominant choice of ovicaprid bones as raw material. The predominant number of finger-holes is three; four and five finger-holes are less common, only three flutes display six finger-holes, and one possesses seven. Surprisingly no correlation between length and number of finger-holes was found. Several flutes with four to six finger-holes are rather short and within the standard size range of 130 - 180mm. Most large bird bone flutes (> 200mm) have four to five finger-holes, but there is also one with two (Table 2-15) and one without finger-holes (Table 2-24). The location and the size of the finger-holes determine the length of the vibrating air column and thus the tone pitch of a flute. A separation of the finds into three types of finger-hole locations (high-, middle- and low-standing[6]) reveals a predominance of middle and low finger-hole locations in association with two to four finger-holes. In contrast, five to seven finger-holes are always located high. An analysis of the geographical distribution of the different types of finger-hole numbers and locations leads Brade to the hypothesis that the latter may be a wide-spread and general functional manufacturing principle while in the former local manners dominate the manufacturing process. Finger-holes are always circular and have been applied perpendicular to the bone surface, mainly by drilling, often with subsequent carving of the edge of the hole. The diameter of the finger-holes ranges from 2.2 – 6.2mm with a mean of 3 – 4mm. There is no correlation between the length of a flute and the diameter of the finger-holes. Thumb-holes appear on 20% of the finds (n = 25). There is no strict correlation between the existence of a thumb-hole and the number of finger-holes, but it seems that flutes with six or more finger-holes often possess a thumb-hole. The location of the thumb-hole in relation to the last finger-hole is in nearly all cases above the first finger-hole (high), only two Norwegian flutes possess a low thumb-hole[6]. Shape and size of the blow-hole and especially the labium (the distal edge of the blow-hole used to cut the air-current) are of importance for the acoustic character of a flute. Circular, D-shaped or square shapes are the dominant forms of medieval blow-holes. The size of the blow-hole ranges from 4 – 7mm in height and from 5 – 9mm in breadth. The blow-hole is in most cases situated between 10 and 30mm from the upper margin. There is a correlation between the number of finger-holes and the shape of the blow-hole: six finger-holes correlate always with square blow-holes. A straight-lined labium set perpendicular to the bone axis with an oblique sharpened edge has the best acoustic qualities, but only a minor number of medieval flutes show this feature (Brade 1975, 26-38, 45-48).

The Vechta flute belongs to the type "K h 6 + 1e", where "K" stands for duct flute (in German *Kernspaltflöte*), "h 6" for six high-standing finger-holes and "+ 1e" for one thumb-hole located opposite (equal) to the last finger-hole. A comparison of the Vechta flute with regional finds shows that it is longer than any other regional example. The number of six finger-holes is a rare case. The size, shape and location of finger-holes and blow-hole fits into the observed typological scheme. The shape of the blow-hole is typical for a duct flute. The diameter of the finger-holes is at the lower margin of the observed range, a fact that may be related to the slender shape of the juvenile bone. The edges of the finger-holes show no traces of working beyond the drilling process. The combination of six high-standing finger-holes with a square blow-hole is consistent with the regional observations but points into the direction of supra-regional manufacturing principles. The existence of a thumb-hole opposite to the first finger-hole is a feature without regional comparison. The combination of a square blow-hole with a straight and sharpened labium, six finger-holes and one thumb-hole is an expression of an advanced manufacturing technique. There is no decoration.

Geographical, cultural and chronological considerations

As has been pointed out in the previous section, flutes with six finger-holes are exceptional in Middle and

Northern Europe, but they are common in the Mediterranean and Balkan region[7]. According to Moeck (1977, 14, 24-25, fig. 32, 60-61) and Brade (1975, 46-49) thumb-holes are in most cases located above the first finger-hole (high-standing). Examples with thumb-holes opposite to (equal) or below the first finger-hole are rare. Finds of the latter two types in combination with six finger-holes and a square blow-hole are restricted to the Mediterranean region[8]. Moeck and Brade associate them with Islamic influences.

Focusing on the Middle Ages, there appears to be a preference for vulture ulnae as a favoured raw material for musical instruments in the Iberian Peninsula. Apart from the flutes from Del Val, Zaragoza and Alarcos (Table 1-6, 1-8, 1-9) there are nine drilled and decorated vulture ulnae that probably represent parts of musical instruments other than flutes[9]. It is noticeable that except the flutes from Vechta and Del Val (Table 1-6), all medieval finds are related to Islamic contexts. This is backed by the association of vultures with magical beliefs in the Islamic culture, as Becker (2005, 334) points out. A comparison between the instruments from Islamic contexts with the pre-medieval finds shows a significant difference and an advance in the accuracy of the manufacturing technique and efforts taken in decoration (Moreno-Garcia *et al.* 2005, 341-342). A reflection of this cultural affinity to vultures may be found in modern vulture bone flutes in Iberian folklore (Table 1-12 to 1-22). Worth mentioning in this regard are modern folklore flutes from Palestine[10] and Turkey[11] made from eagle bones, as they again point towards Islamic culture.
The Vechta flute is not decorated but it is extraordinary in respect to its fine workmanship compared to other local flutes. This, combined with typological reasons, supports the hypothesis that the Vechta flute originally belonged to an Islamic context as well.

Replication

In January 2008, in Lisboa, Carlos Pimenta and the author built two metrically exact replicas of the flute from right ulnae of adult griffon vultures. Both ulnae were retrieved from vultures found dead by environmental staff in Portugal 2007. One was found in the Peneda-Gerês National Park (CIPA n°2083), the other in the Parque Ecológico de Monsanto, Lisboa (CIPA n°2041). The replicas were manufactured with modern tools (bench vice, handsaw, drilling machine, files, scalpel, sandpaper, Dremel-Mini-Tool) (Figure 4). One replica is now housed in the Museum im Zeughaus Vechta (n°2041), the other in the Labóratorio de Arqueozoologia Lisboa (n°2083).

The analysis of the replicas for their acoustic and musical capacities[12] is not finished. The first preliminary results were produced by flute builder Edith Exo (pers. com. 4-6/2008). Exo equipped the replica with a block made of bee's wax. This way it can be played as a recorder with a melodic, yet very low sound. A whole scale can be played, but the intonation is not 'spotlessly clean'. After tuning by the enlargement of finger-holes 2, 4 - 6 and the thumb-hole to a diameter of 3.5 – 4.0mm the intonation was clean with a pitch range covering one and a half octaves.

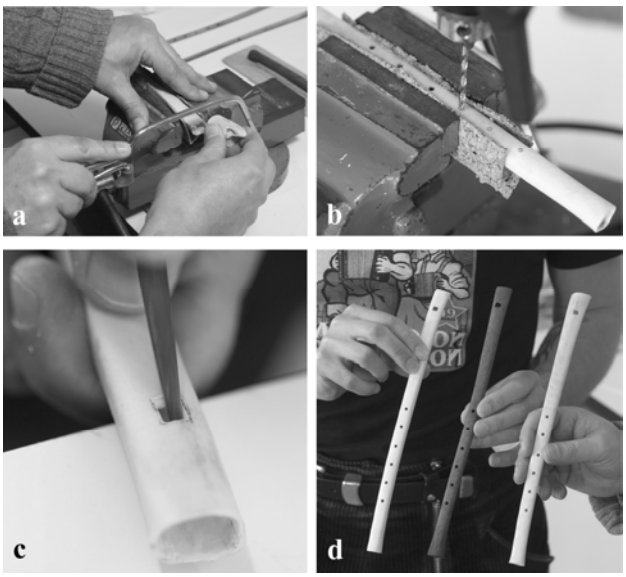

Figure 4: Replication of the Vechta vulture bone flute (photos: J. Paulo Ruas).

Historical settings

What kind of conclusions can we draw at present from the facts outlined above? How does a bone flute made of a highland bird species reach a medieval North German marshland town? Of course all possible answers to this question are hypothetical but it might be interesting to sum up the imaginable options, to weigh them in light of the facts and to sort them into more or less probable assumptions. In principle, three options are possible:

- Option A: The bone came to Vechta in the body of a living bird, either a wild migrating vulture or a captive animal. After its death a local craftsmen manufactured the flute from its ulna.
- Option B: The wing of a vulture was imported from abroad from which a local craftsman manufactured the flute.
- Option C: The finished flute was imported from abroad.

As discussed before, the appearance of a wild juvenile vulture in Vechta is highly unlikely. However, captive exotic animals were sometimes kept at aristocratic courts as status symbols. They were (and still are) used as diplomatic exchange gifts. Examples are the keeping of peacocks and fallow deer by the aristocracy since the Middle Ages. Wealthy people used parts of bird wings as fans. An argument against options A and B are the

typological differences between the Vechta flute and other local flute finds. For a North European background a vulture may not appear to be an adequate choice if the presentation of status is desired, but this may change if a foreign origin is taken into account. Most plausible to me seems option C. In addition to the zoological and typological arguments for an import of the finished artefact, there is historical evidence for contact between local nobles and the Mediterranean region. Earl Gerd der Mutige (Gerd the Brave) of Oldenburg, a neighbouring town, died in 1500 on his return from a pilgrim's voyage to Santiago de Compostela. A local legend tells about the participation of another Earl of Oldenburg in a Palestinian crusade in the 13th century. The most convincing idea for me is that of a travelling musician from the Mediterranean region who brought his instrument and broke it in Vechta[13].

Contrary to the evidence suggesting a Mediterranean origin, one historical fact has to be mentioned pointing towards Southern Germany: the aforementioned noble Jutta von Ravensberg married the Earl Wolfram von Monschau in 1251 and moved to his home in the Eifel mountains in the federal state Rheinland-Pfalz. She lived there until 1266 but kept contacts with Northern Germany and probably visited Vechta more or less frequently until her death around 1302. Monschau is situated less than 100km from the 13th century griffon breeding habitat in the Hunsrück mentioned by Albertus Magnus. Therefore a southern German origin cannot be completely ruled out, but the typology and the lack of comparable finds speak against this argument.

Summary

The bird bone flute presented here, from a presumably 14th century deposit from Vechta, Niedersachsen, Germany, could be assigned to a right ulna of a vulture, most probably a griffon vulture (*Gyps fulvus*). The geographic distribution of this bird species does not correlate with the location of the find. A preliminary typological assessment highlights differences between the Vechta flute and regional flutes, making a local origin unlikely. The specific combination of functional features as well as the zoological analysis point towards a geographically Mediterranean and culturally Islamic origin.
A review of the references on medieval large bird bone flutes shows that the Vechta flute is one of the best preserved examples of its kind. This allowed the possibility to produce exact replicas. An acoustic analysis of the replicas is under way and it may be possible for the original to be analysed acoustically in the future.

Note 1*: see for instance Assendorp 2008; Bischop 2005; Brade 1975; 1978; Erath 1996, 207; Grefen-Peters 2005; Lehmkuhl 1985; Lehnert 1997, 61-62, pl. 19.2; Moeck 1977; Rech 2004, 391-392, fig. 397.3; Tamboer 1999, 10-11; Ulbricht 1984, 40-41, 61-62, pl. 43, 91.*

Note 2*: Spanish griffons were recorded up to 600km away from their breeding range (Cramp and Simmons 1980, 75); a griffon vulture ringed as a fledgling in the 1970s in France was recorded in the Lori-region of Armenia in the late 1980s, a distance of more than 3300km (Aghababian pers. com. 30. 4. 2008).*

Note 3*: If anybody is aware of finds not mentioned in this paper, a note would be highly appreciated.*

Note 4*: One additional Roman flute stored at the Landesmuseum Mainz, Germany (Mikler 1997, 32, 131, pl. 23.1; inv. n° R 2385) shall be mentioned here. It is not zoologically identified yet, but its size (L = 245mm) includes the option of another vulture bone flute.*

Note 5*: Besides the examples mentioned in Table 1-2 see e.g. Ayalon and Sorek 1999, 46, fig. 57-58; Krenn 1996, 29, fig. 21; Mikler 1997, 32, 131, pl. 23; Moreno-Garcia 2005; Moreno-Garcia* et al. *2005, 337-341, fig. 8-9; Münzel 2004; Pimenta and Moreno-Garcia 2007; Schallmayer 1994; Serjeantson (in prep.); Tsvetkova 1970, fig. 22.22; Zhang* et al. *1999.*

Note 6*: Typological terms used here follow the definitions of Moeck (1977, 17-18) and Brade (1975, 33, 36, 61-62): numbering of finger-holes begins at the lowest hole as this defines the base pitch of the flute; location of finger-holes (fh): high = last fh above half of flute length, middle = last fh between 1/2 and lower 1/3 of flute length, low = last fh below lower 1/3 of flute length; location of thumb-hole: high = above last fh, equal = opposite to last fh, low = between last and 2nd-to-last fh.*

Note 7*: Several examples are reported from Southern France, Spain, Portugal, Italy, Croatia, Slovenia, Slovakia, Bosnia, Serbia, Macedonia, Greece, Bulgaria, Hungary and Romania; see Tables 1-6, 1-15, 1-17, 1-18; 2-1, 2-25 and Moreno-Garcia and Pimenta 2004, 417-423; Moreno-Garcia* et al. *2005, 332-333; Moeck 1977, 21-23, fig. 37a, 41, 45-51.*

Note 8*: One rare exception worth mentioning is a flute type from Scandinavia with 5 - 8 finger-holes plus one high or equal thumb-hole, but this type is always combined with a D-shaped blow-hole (Brade 1975, 46-48, 76-77, pl. 11a, DK 7, 15; Moeck 1977, 22, 25, fig. 42).*

Note 9*: Finds from Albarracin, Alarcos, Jaén, Spain and Mértola, Portugal (Moreno-Garcia and Pimenta 2004, 417-419; 2006, 227-235, fig. 1-5, 7; Moreno-Garcia* et al. *2005, 334-341, fig. 5-9)*

Note 10*: Ayalon and Sorek (1999, 46, fig. 58) present a mid 20th century Beduin reed flute from the Arad region, Israel; it is a double flute made of two eagle ulnae equipped with six finger-holes each.*

***Note 11**: The Cigirtma is a flute made from eagle ulnae played by Turkish herdsmen with six finger-holes and one thumb-hole: (http://www.discoverturkey.com/english/kultursanat/b-h-cigirtma.html).*

***Note 12**: For acoustic research about archaeological flute finds see for instance Brade 1975, 51-83; 1978; Hahn and Hein 1995; Hein and Hahn 1998; Hickmann* et al. *2002; Lochner 2000; Oomen 1968; Paniagua 2007; Seeberger 2004; Zhang* et al. *1999.*

***Note 13**: For notes about travelling musicians see* e.g. *Brade 1975, 49, 58; Moreno-Garcia* et al. *2005, 346.*

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N°	vulture species	location	dating, culture	functional features: flute type; length (L); finger-holes (fh) + thumb-holes (th) diameter (ø); blow-hole (bh); decoration (d)	reference, archive, inventory N°
1	griffon or black (Aegypiinae)	Isturitz, France	20000-35000 BP, Upper Palaeolithic	18 finds; fh carved; d linear scratches	Brade 1975, 17-18, pl. 1c-f; Lawson and d'Errico 2002; Moreno-Garcia and Pimenta 2004, 417-418; Serangeli 2004; Musée des Antiquités Nationales Saint-Germain-en-Laye
2	vulture	Veyreau, France	Chalcolithic	duct; L 175 mm; 5 high fh ø 5-7mm, carved; bh square 6 x 8mm	Becker 2005, 332-333, fig. 4; Moreno-Garcia and Pimenta 2004, 417-418
3	griffon (*Gyps fulvus*)	Conímbriga, Portugal	Roman	L 238mm; 5 high fh ø 5.0-7.7mm, carved	Moreno-Garcia and Pimenta 2004; Moreno-Garcia *et al.* 2005, 330-344, fig. 2-3; Museu monográfico de conimbriga, a 57
4+5	griffon, black or bearded (Aegypiinae)	Mook, Netherlands	Roman	2 flutes; L 260mm; 5 high fh; bh circular	Oomen 1968; Rijksmuseum Nijmegen, 62
6	black (*Aegypius monachus*)	Del Val Roman Villa, Madrid, Spain	6th - 8th century, Hispano-Visigothic	L 257mm; 6 fh ø 4-5mm	Moreno-Garcia and Pimenta 2004, 417-419; Moreno-Garcia *et al.* 2005, 332-333; Museo Arqueológíco Regional Alcalá de Henares, 95
7	griffon (*Gyps fulvus*)	ar-Raqqa, Syria	8th - 9th century, Islamic	duct or nay; fragment L 99mm; 4 fh ø 4.3-4.5mm, carved	Becker 2005
8	griffon / black (Aegypiinae)	Caesar Augusta Roman Theatre, Zaragoza, Spain	11th century, Islamic	fragment L 82mm; 2 fh ø 4,9-5.0mm, drilled; d crossed + zig-zag lines	Moreno-Garcia and Pimenta 2004, 417-419; 2006, 232-233, fig. 6; Moreno-Garcia *et al.* 2005, 334-346, fig. 5-6; Museo del Teatro Romano de Caesar Augusta Zaragoza, vi.2.6-07
9	vulture (Aegypiinae)	Alarcos, Spain	1195, Islamic	duct; L 187mm; 6 high fh + 1 high th; bh rectangular	Paniagua 2007; Parque Arqueológico de Alarcos Calatriva
10	griffon (*Gyps fulvus*)	**Vechta, Germany**	14th century	duct; L 267mm; 6 high fh ø 3mm + 1 equal th ø 3.0 x 3.9mm, drilled; bh square 5 x 5mm	Museum im Zeughaus Vechta
11	griffon (*Gyps fulvus*)	Kaiserebersdorf, Austria	Modern Time (Renaissance)	semi-finished flute: 3 unfinished fh; no bh	Czeika and Ranseder 2007, 60-61
12	vulture	Torres Vedras, Portugal	17th century	fragment L 141mm; 5 fh ø 3.2-5.4mm	Moreno-Garcia and Pimenta 2004, 417-419; Moreno-Garcia *et al.* 2005, 341-342, fig. 11; Museu Municipal Leonel Trinidade Torres Vedras
13	vulture	Robleda, Spain	1880	2 fh + 1 th	Moreno-Garcia and Pimenta 2004, 418-423
14	vulture	Chequilla, Spain	1900 - 1935	transverse; 7 fh + 1 th; bh square	Moreno-Garcia and Pimenta 2004, 418-423; Museo Nacional del Pueblo Español Madrid
15	vulture	Tordesilos, Spain	1980s	duct or nay; 6 fh + 1 th	Moreno-Garcia and Pimenta 2004, 418-423
16	vulture	Alcaine, Spain	1990s	duct or nay; 7 fh + 1 th	Moreno-Garcia and Pimenta 2004, 418-423
17	vulture	Maella, Spain	1990s	6 fh + 1 th	Moreno-Garcia and Pimenta 2004, 418-423
18	vulture	Maella, Spain	1990s	6 fh + 1 th	Moreno-Garcia and Pimenta 2004, 418-423
19	himalayan griffon (*Gyps himalayensis*)	Muktinath, Nepal	end of 20th century	duct; L ca. 306mm; 6 high fh ø 6mm; bh square, block of wood	Becker 2005, 333-334; collection Von den Driesch
20	vulture	Cóccoles, Spain	present time		Moreno-Garcia and Pimenta 2004, 418-419
21	vulture	Huertahernando, Spain	present time		Moreno-Garcia and Pimenta 2004, 418-419
22	vulture	Señorío de Molina, Spain	present time		Moreno-Garcia and Pimenta 2004, 418-419

Table 1: Flutes made of vulture ulnae from different chronological and cultural contexts[*].
[*] *For typological definitions see note 6.*

N°	species	location	dating	functional features: flute type; length (L); finger-holes (fh) + thumb-holes (th) diameter (ø); blow-hole (bh)	reference; archive, inventory N°
1	crane (*Grus grus*), tibiotarsus	Bielo Brdo, Croatia	6th century, Avar	reed; L 260mm; 6 high fh	Gál 2005, 325; Kozák 1997; Arheolski Muzej Zagreb
2+3	crane (*Grus grus*), ulnae	Jánoshida, Hungary	6th - 8th century	double reed; A: L 169mm; 5 high fh; B: L 175mm; 2 middle fh; ø fh 4.0 – 5.5mm	Bartha 1934; Gál 2005, 325; Kozák 1997, fig. 2.6, 3.1; Hungarian National Museum Budapest, 5/1933
4+5	crane (*Grus grus*)	Alattyán, Hungary	7th century, Avar	double reed; L 170mm; 5 high fh each	Gál 2005, 325; Kozák 1997, fig. 2.1; Hungarian National Museum Budapest
6+7	crane (*Grus grus*)	Alattyán, Hungary	7th century, Avar	double reed; L 160mm; 5 high fh each	Gál 2005, 325; Kozák 1997, fig. 2.2; Hungarian National Museum Budapest
8+9	crane (*Grus grus*)	Szegvár, Hungary	7th century, Avar	double reed; fragment; 4 high fh each	Gál 2005, 325; Kozák 1997, fig. 2.3; Móra Ferenc Múzeum Szeged
10 + 11	crane (*Grus grus*)	Rácalmás-Rózsamajor, Hungary	7th century, Avar	double reed; L 185mm; 5 high fh each	Gál 2005, 325; Kozák 1997, fig. 2.4; Intercisa Múzeum Dunaújváros
12 + 13	crane (*Grus grus*)	Felgyö, Hungary	7th century, Avar	double reed; L 182mm; 5 high fh each	Gál 2005, 325; Kozák 1997, fig. 2.5; Koszta József Múzeum Szentes
14	sea or golden eagle (Buteoninae), ulna	Haithabu, Germany	9th - 10th century	fragment L 156mm; 4 fh ø 2.7-3.0mm	Brade 1975, 73-74, pl. 5e, D 12; 1978, fig. 1.1, 2.1; Archäologisches Landesmuseum Schleswig
15	large bird[3], ulna	Haithabu, Germany	10th century	fragment L 213mm; 2 low fh ø 4.5mm, carved; bh D-shaped	Brade 1975, 74, pl. 5a, D 15; 1978, fig. 1.3, 2.3; Archäologisches Landesmuseum Schleswig
16	large bird	Huizum, Netherlands	medieval	duct; L 216mm; 4 low fh ø 4.0 – 5.5mm; bh inverse D-shape	Brade 1975, 29-30, 65, pl. 2d, NL 17; Moeck 1977, fig. 14; Fries Museum Leeuwarden, 15 A 76
17	swan (*Cygnus* sp.), ulna	Westerwijtwerd Netherlands	medieval	duct; L 212mm; 4 low fh ø 3.7 – 5.5mm; bh D-shaped	Brade 1975, 29-30, 63, pl. 2c, NL 5; Museum voor Stad en Lande Groningen, 1890/VI 11;
18	large bird	Hoogebeintum, Netherlands	medieval	duct; L 231mm; 4 low fh ø 4.0 – 5.7mm; bh D-shaped	Brade 1975, 29-30, 66, pl. 2b, NL 23; Fries Museum Leeuwarden, 28-669
19	large bird, ulna	Hatsum, Netherlands	medieval	duct; L 215mm; 5 high fh ø 4.0 – 5.0mm; bh circular	Brade 1975, 29-30, 68, pl. 2f, NL 32; Fries Museum Leeuwarden, 49 A 153
20	large bird	Ylst, Netherlands	medieval	duct; L 194mm; 4 low fh ø 4.0 – 6.0mm; bh D-shaped	Brade 1975, 69, pl. 2e, NL 39; Rijksmuseum van Oudheden Leiden, e 1953/8.1
21	large bird, ulna	Dokkum, Netherlands	medieval	duct; L 236mm; 4 low fh ø 5.0 – 6.5; bh square	Brade 1975, 70, pl. 2a, NL 44; Admiraliteitshuis Dokkum, 625
22	mute swan (*Cygnus olor*), ulna	York, England	11th - 12th century	duct; L 182mm; 1 fh, carved; bh D-shaped	MacGregor 1999, 1977-1978, 2021, fig. 935; York Archaeological Trust, 18366 sf3565
23	eagle (Accipitridae), ulna	Schleswig, Germany	11th - 14th century	duct	Ulbricht 1984, 40, pl. 44; Archäologisches Landesmuseum Schleswig
24	heron (*Ardea* sp.)	Oudkrabendijke, Netherlands	late medieval	duct or nay; 0 fh; bh D-shaped	Tamboer 1999, 10-11; Museum Boijmans van Beuningen Rotterdam
25	golden eagle (*Aquila chrysaetos*), ulna	Visegrád, Hungary	16th century	duct; fragment L 149; 6 high fh ø 4.3-4.5mm + 1 low th ø 4.4mm	Gál 2005, 328, 335, fig. 6; Visegrád Múzeum, 63.26.1
26	eagle (Accipitridae), ulna	Visegrád, Hungary	16th century	fragment L 105mm; 5 fh ø 4.1-4.7mm + 1 th ø 4.2mm	Gál 2005, 328, fig. 7; Visegrád Múzeum

1: Birds with bones longer than 200mm.
2: As has been regretted by others before (e.g. Lehmkuhl 1985, 138; Moreno-Garcia *et al*. 2005, 329-330, 346; Serjeantson in prep.) archaeologists often show only limited interest in the zoological data of these artefacts although they can reveal valuable additional information. No zoological details were available for the bird bone flutes from Westeremden, Jelsum, Blija, Hantum, Spannum, Witmarsum, Banter Teich, Skanör, Eketorp (Brade 1975, 65-69, 73, 79-80, pl. 3c, 6d, 7a, 8g, 11e, NL 14+15, 19, 25, 27, 34, 36, D10, S 10, 16).
3: According to Brade (1975, 74) swan (*Cygnus* sp.), according to Brade (1978, 29) sea eagle (*Haliaeetus albicilla*) or golden eagle (*Aquila chrysaetos*).

Table 2: Medieval flutes made of large bird species except vultures (for typology see note 6).