LATE MEDIEVAL BONE BEAD PRODUCTION: SOCIO-ECONOMIC ASPECTS BASED ON MATERIAL FROM CONSTANCE, GERMANY

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Summary

This paper presents the preliminary results of a study of a massive find of bone bead production refuse from three different production phases dated between the late 13th and the early 16thcenturies. Differences in the choice of skeletal elements, in the efficiency of use of these raw-materials, and in the form of the products, indicate a growing degree of rationalization. Though at first accompanied by a growing pressure on supply of raw material, this development continued into the 15th century independent of the changing relationship between the availability of raw material and demand for it, showing early signs of mass production.

Résumé

Fabrication de perles en os au Moyen Âge tardif : aspects socio-économiques sur la base de découvertes faites à Constance, Allemagne.

Cet article présente des résultats préliminaires de l'étude d'une découverte massive de débris de fabrication de perles datant de trois phases de production différentes, s'étageant entre la fin du 13e et le début du 16e siècle. Des différences dans le choix des éléments squelettiques, dans le rendement de l'utilisation de ces matières premières et dans les formes des produits indiquent une croissance du degré de rationalisation. D'abord accompagné d'une pression croissante sur les matières premières, ce développement s'est poursuivi au 15e siècle, indépendamment du rapport changeant entre offre et demande des matières premières, montrant des signes précoces de production en masse.

Zusammenfassung

Spätmittelalterliche Herstellung von Knochenperlen: sozialwirtschaftliche Aspekte anhand von Funden aus Konstanz, Deutschland.

Der Beitrag behandelt vorläufige Resultate der Untersuchung eines massenhaften Abfallaufkommens mittelalterlicher Knochenperlenproduktion. Über drei Produktionsphasen verteilt, datiert das Material zwischen dem späten 13. und dem frühen 16. Jahrhundert. Unterschiede in der Auswahl der Skelettelemente, in der Ausnutzung dieser Rohmaterialien und in der Form der Produktion weisen auf ein wachsendes Maß an Rationalisierung hin. Anfangs mit einer relativen Verknappung der Rohmaterialien verbunden, setzte sich diese Entwicklung - unabhängig von Rohstoffangebot und Nachfrage - im 15. Jahrhundert fort. Hierin zeigen sich frühe Hinweise auf eine Massenproduktion.

Key Words

Medieval, Industry, Boneworking, Technics, Constance.

Mots clés

Moyen Âge, Industrie, Technologie, Travail de l'os, Constance.

Schlüsselworte

Mittelalter, Handwerk, Technik, Knochenbearbeitung, Konstanz.

During excavations near the fishmarkt in the medieval town centre of Constance in southwest Germany (fig. 1) from May 1984 till August 1986, a rather peculiar find in the field of bone working was found: more than 300,000 fragments of flat strips of animal bones with series of circular perforations, together with about forty to fifty thousands chopped off distal ends of cattle-metapodials, all in an area of about 240 m^2. They are momently studied with a grant from the Gottlieb Daimler-und-Carl Benz-Stiftung in Ladenburg (Germany). This paper presents some preliminary results.

Similar finds of perforated bonestrips are known from many medieval towns from Estonia to England and from Hungary to northern-France[1]. In some cases they were as massive as in Constance. In the Dutch town of Den Bosch, a 16th century earthwall was filled with this material (Jansen, 1983). In 15th century Strasbourg (Maire, 1990), just as in 15th century Constance (Oexle, 1984), they were

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[1] Respectively: pers. comm. L. Maldre, Tartu (Estonia); MacGregor, 1985: 101-102 (England); Meyer, 1979 (France); Sandor Maria, 1961 and pers. comm.; L. Bartosiewicz, Budapest (Hungary).

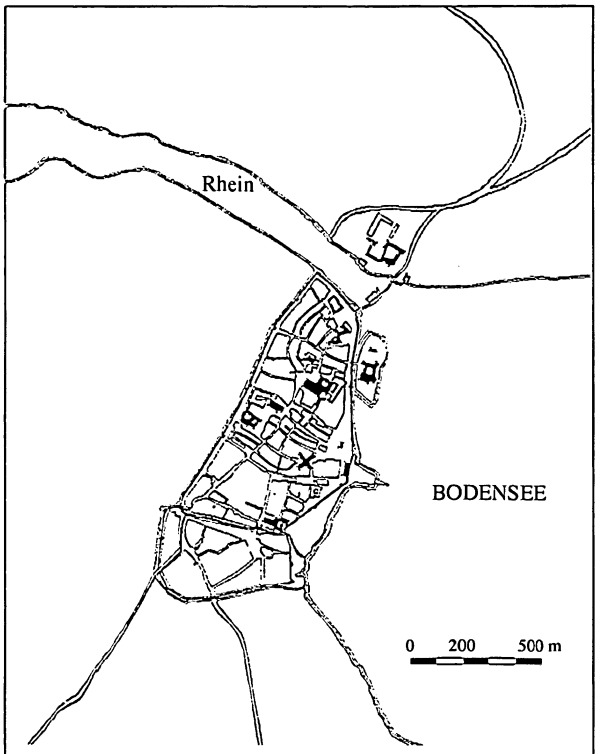

Fig. 1: Fifteenth century Constance with the findspot (X) of the waste of bone-bead-production near the Fischmarkt. Drawing D. Bandemer.

used to raise a marshy area in the townskirt. Finds from monasteries or agricultural villages are also known, but clearly more rare. Nearly all finds are dating from the 13th to 18th centuries. The material from Constance is dated between the late 13th and the early 16th centuries.

The perforated bonestrips presented in this paper are the waste of the production of beads, ringlets and buttons by means of drilling. An iron drill was used with a profile showing the negative of the desired object and a longer, pointed pin in the middle (fig. 2). Put at right angle to the bonewall, a hole was pierced, first with the central pin through the wall till the other side. Then, with the rest of the profile, the bonewall was drilled till halfway. The bonestrip was then turned, the central pin put into the hole and the other half was carved till the two carvings touched and the object fell out of the strip, leaving a circular hole. Where the two carvings had touched, a ridge is often visible. Finally, the object could be polished and dyed or covered with textile (MacGregor, 1989). Depending on the profile of the drill, this led to a bead, a ringlet or a button.

Early examples of bone buttons from Constance were drilled from one side only (fig. 3). The find-dispersal in Constance as well as in Strasbourg seems to indicate that buttons have been made in different workshops from the great mass of beads and ringlets. The oldest bone-buttons, from Constance as well as Basel and Strasbourg, are from the second half of the 15th or first half of the 16th centuries. In the Middle Ages, clothes were closed, among others, by hanging loops around knots, made from leather or other material (fig. 4). At the end of the Middle Ages the knots were enlarged with circular bone discs with one hole, to give the loops a better holding. Later the discs replaced the knots and got more holes to fix them by sewing (Moosbrugger-Leu, 1985).

The beads and ringlets during the Late Middle Ages were mainly used for prayer counting chains. These were called rosaries or "paternosters" after the prayer for which they were mostly used. Paternoster chains were widely used among all classes, not only for strictly religious use,

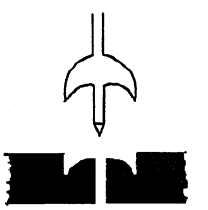

Fig. 2: Schematic section of a bonestrip, drilled from one side till halfway, with drill.

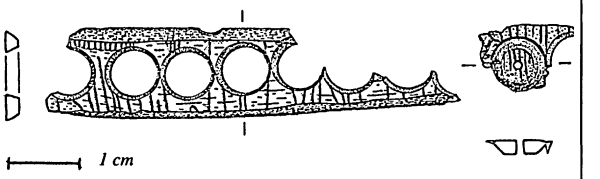

Fig. 3: Bonestrips drilled from one side, Constance, Markstätte. Drawing C. Bürger.

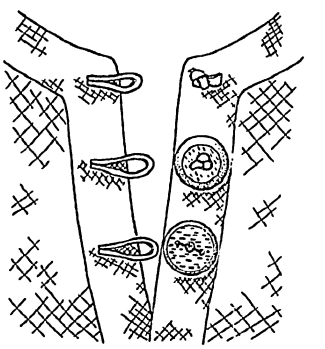

Fig. 4: Schematic reconstruction of the development of bone buttons (down) from knots (at the top) through bone discs with one hole (middle) at the end of the Middle-Ages (partly after Moosbrugger-Leu, 1985). Drawing C. Bürger.

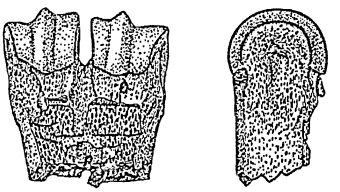

Fig. 5: Chopped off distal end of cattle-metatarsal. Drawing C. Bürger.

and made from different materials, like various metals, glass and wood, in different price classes, for the different classes of society. The cheapest material suitable for the production of beads, however, was bone, remaining in large quantities as slaughtering refuse.

Two skeletal elements of cattle were found in huge quantities in the production refuse of Constance as well as Strasbourg: metapodials and the meatless part of the *rami horizontali* of mandibulae. Other bones being as suitable, or even more suitable as these for the bead production were only used in limited quantities. I suppose that they were not systematically available in large quantities in complete

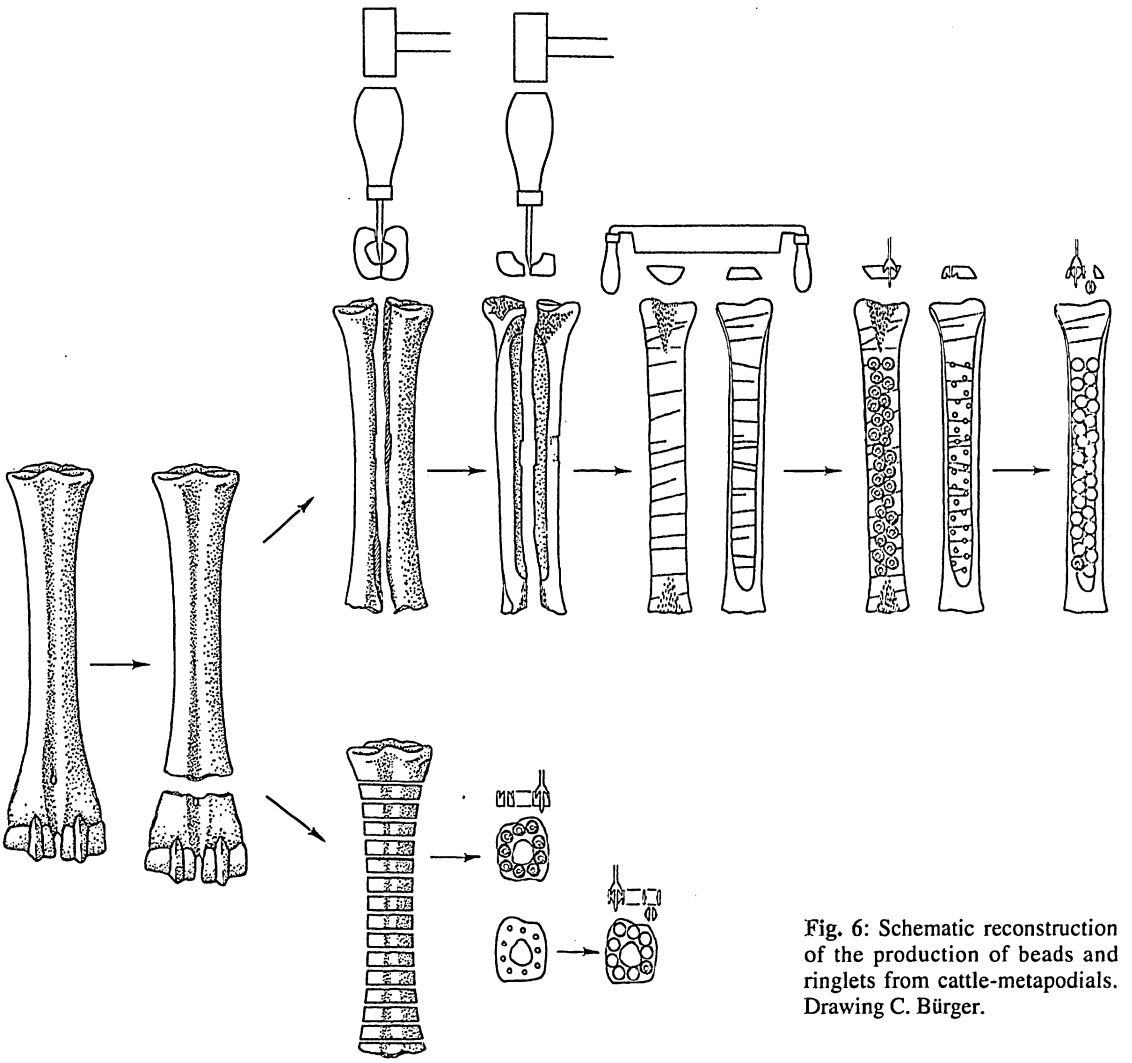

Fig. 6: Schematic reconstruction of the production of beads and ringlets from cattle-metapodials. Drawing C. Bürger.

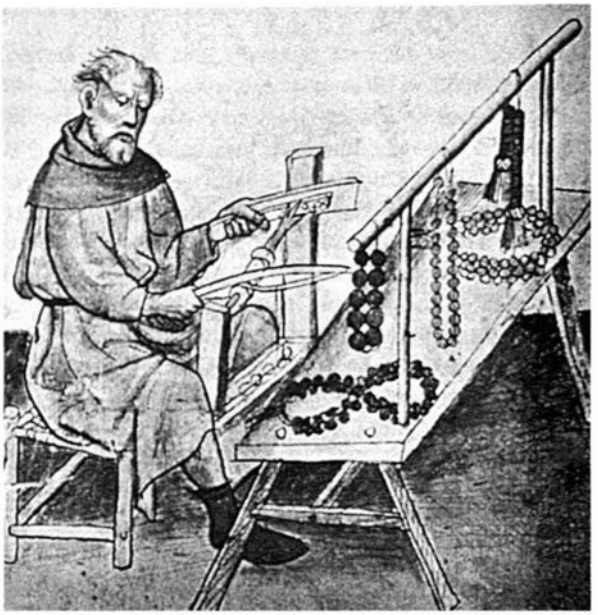

Fig. 7: Drawing of a Paternostermaker with drilling-bench dated 1425-1436 (Brückmann, 1965: Verlagsnr. 1232; Facsimile of Stadtbibliothek Nürnberg Amb. 317.2o, fol 6v).

state. Apparently the meat carrying bones of cattle were not separated from the meat by the butcher, but went to the consumer, among whoms garbage they are found in chopped and broken state in the backyards all over the medieval towns. Whereas the meatless metapodials and *rami horizontali* apparently were separated from the meat by the butcher and could be obtained in large quantities. If they did not go with the skin to the tanner and remained in the skin during tanning (Serjeantson, 1989), the bones had to be cooked for about one and a half to two hours. Experiments showed the necessity of such a treatment to clean them from fat and strings and make them easier to process. After this treatment the distal ends were chopped off around the *foramen* with a heavy chopper or axe (figs. 5 and 6). Experiments showed that this was quite hard in untreated state.

A narrow chisel, wide about 12 millimeters, was used to split the remaining part of the metapodia. The chisel width is deduced from chiseltraces on split metapodial shafts. Experiments showed that when a wider chisel is used, the shaft is more often not splitting along the desired directions. The strips then were roughly flattened with a draw-knife or a chopping-knife.

Pictures from the early 15th century onwards show various kinds of work benches being used for the drilling (fig. 7). From the fact that the described breaking ridges in the walls of the perforations in the bonestrips often are exactly on the same hight, it can be deduced that the drilling benches used in Constance and Strasbourg already in the early 14th century had a blockade that prevented the drill from drilling beyond a certain depth, mostly halfway the bonewall (fig. 8). The Constance material can be divided into three different phases showing differences in the choice of raw materials and in the range of the products. They show a development in the way of production.

The first phase gives the impression of a small-scale production, for example as subsidiary occupation. Only ringlets with a circular section seem to be produced (fig. 9: 1-5). About one thousand perforated strip-fragments have been found, which is rather trifling compared to the other phases. Mostly they were made from cattle-metapodials. It seems that their supply was sufficient. Apart from them, to a small extent, all sorts of bones were used without any systematic choice. They might well have been taken from the refuse of the own household. Even quite unsuitable bones were used, like the *ramus verticalis* of a cattle

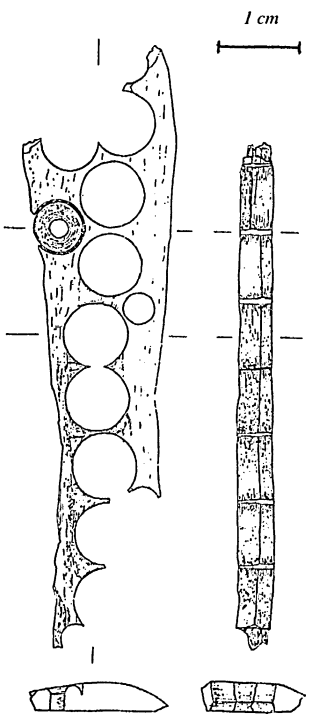

Fig. 8: Perforated bonestrip with ringlet and breaking-ridges in the walls of the holes. Drawing D. Bandemer.

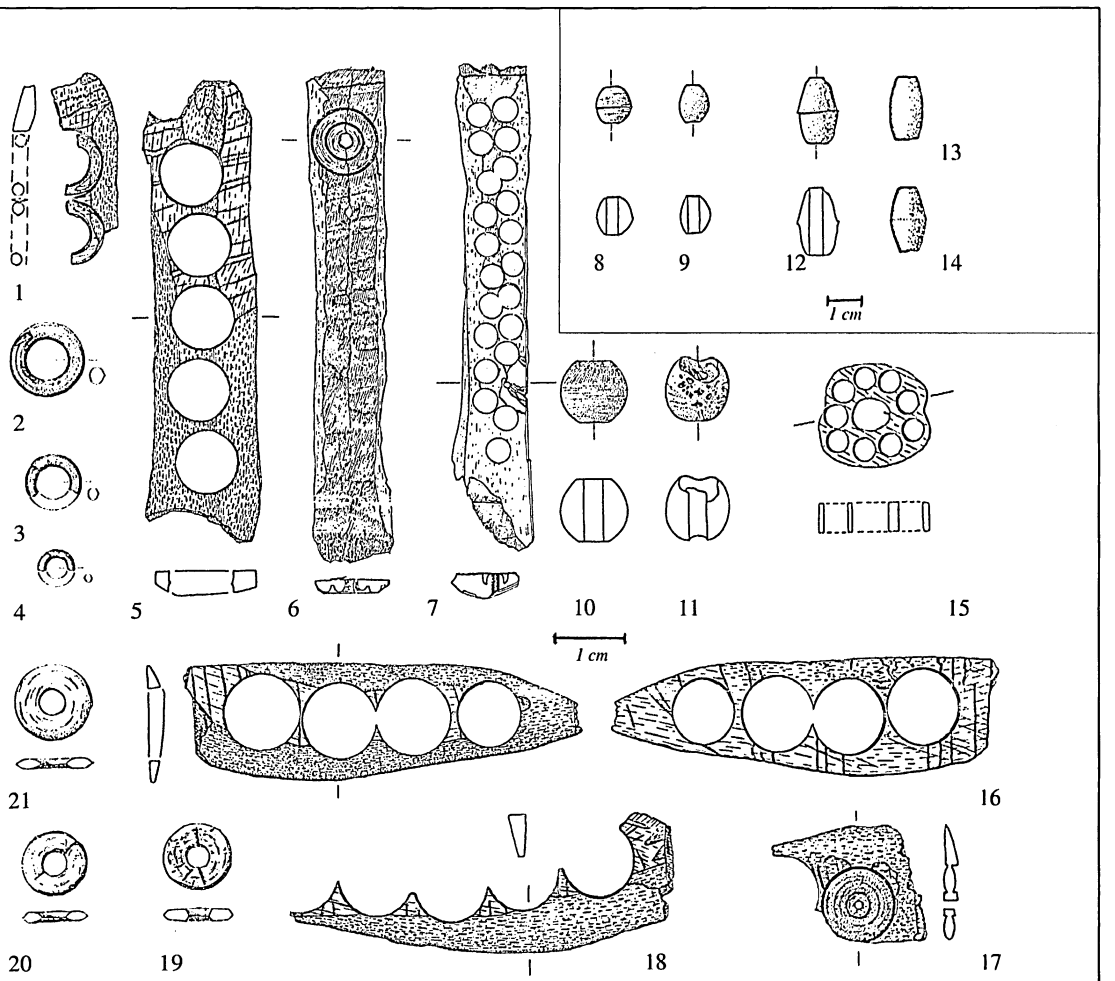

Fig. 9: Bone strips, beads and ringlets from Constance, Fischmarkt, Phase I (nrs. 1-6); Phase 2 and 3 (nrs. 7-15) and Phase 3 (nrs. 16-21). Nrs 1-5, 16-21, 11, 13: drawing C. Bürger. Nrs 6-12: drawing D. Bandemer. Nrs 13-15: Oexle 1985 resp. Abb. 726; 727 and 720 (p. 484 and 486).

mandible (fig. 10), or the rather thin part of an occipitale of cattle. The metapodials were split in such a way that no more than two strips could be made out of them, which were, however, as wide as possible (fig. 11A). For the drilling of ringlets it is more important that the bonestrip is wide, rather than as thick as possible.

However, in the second phase, the metapodials were split into four strips (fig. 11B), which were not so wide, but in the middle as thick as possible. Out of these, mainly beads were drilled: large quantities of little beads with a diameter of 4 to 5 mm (fig. 9: 8-9) as well as some larger beads (diameter 6 to 12 mm; fig. 9: 10-11). Through producing beads instead of ringlets it was possible to get four times as many objects out of the same bone surface, as beads have a much smaller horizontal diameter than ringlets (fig. 9: 5-7). So the use of the raw material was more efficient than before. The production also seems to have been on a much larger scale. The paternosterer refuse of the second phase was found in immense quantities (not less than 350 kg, or about 150,000 fragments of perforated strips) in high concentrations in layers of several decimeters in some cases consisting almost entirely of perforated bonestrips. It might well be the primary deposited refuse of a workshop known from textual

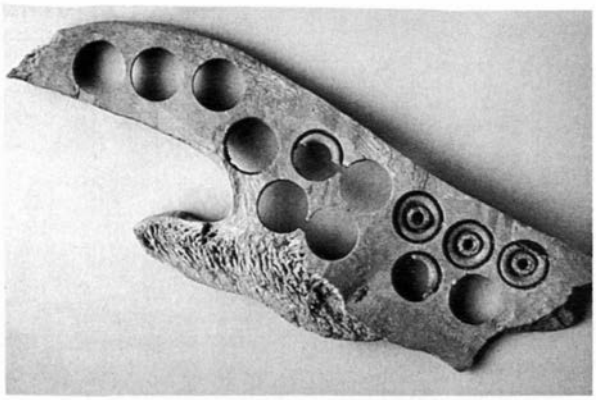

Fig. 10: *Ramus verticalis* of Cattle, used to make ringlets, Constance, Fischmarkt, Phase I. Photogr. M. Schreiner, Arch. Landesmuseum Konstanz.

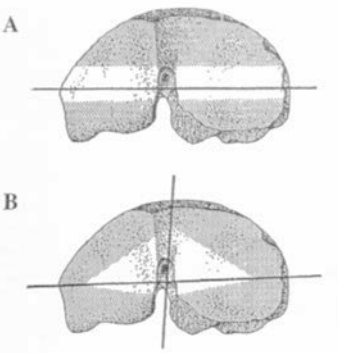

Fig. 11: Splitting patterns of cattle-metapodials. A: Phase1; B: Phase 2. Rastered: used parts.

Fig. 12: Constance, Fischmarkt, transversily sawed slices of cattle metatarsals, with biconical beads. Photogr. M. Schreiner, Arch. Landesmuseum Konstanz.

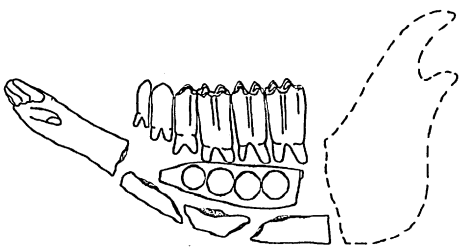

Fig. 13: Waste pieces from the working of *ramus horizontalis* of cattle-mandibles, found at Constance, Fischmarkt.

sources[2] in the years between 1380 and 1391 to have been situated on a courtyard in an alley 50 m above the findspot. One could imagine Mr. Cüntz Paternosterer or his mate Schrawli carrying the bone-refuse in a wheelbarrow downhill to tumble it down on the shore of the Bodensee. Only the excavated and dated part of this refuse already allows for a production of more than half a million beads and ringlets, which amounts, for one man in a period of 10 years with 250 working days to 200 beads per day, or one bead in three to four minutes. If metapodials only would have been used for the production of beads in the way described before, about 10,000 metapodials would have been needed to produce them[3]. Spread on a period of at least ten years, this would mean that at least 250 cattle per year had to be slaughtered. This seems not too much for a medieval town of about 6000 inhabitants (Kirchgässner, 1960). It seems however that the supply of cattle metapodials reached its limits. Apart from cattle metapodials, radius and tibia of cattle were used, as well as radius, tibia and metapodials of horse, all to a limited extent but quite systematically, not mixed with any other skeletal elements. All these bones were quite suitable for bead production, but apparently not easily available in large quantities. (Horses will not have been slaughtered in such large numbers as cattle. For the cattle zygopodium the reasons are discussed above.) Another way to use the available raw material more efficiently was sawing cattle

[2] The textual sources about the paternosterer are widely discussed by Höfler (1990). Meier (1986: 51) quotes a mention of a "paternosters-house" in the Tirolergasse 3/5.

[3] About 7000 metapodial ends are found in the same layers.

and horse metapodials transversally in slices with a thickness of 4 to 8 mm (figs. 6 and 12). The beads were drilled parallel to the length of the boneshaft, and tended to be longitudinal, that is higher than wide, because their width was limited by the thickness of the bone wall, while their length was in principle unlimited (fig. 9: 12-15). This technic might have been more labour intensive, but made it possible to get a larger number of beads out of one metapodial. The refuse of this technic is only known from the massive finds of bone bead production refuse from Constance, Strasbourg and Den Bosch.

The Constance material from around 1400 gives the impression of an organized, professional workshop. It can be recognized that the work was more systematized and split into standardized actions following regular, well considered patterns.

The material from the third phase shows a sharp decline in efficiency in the use of raw material, but a growth in standardization. Only cattle metapodials were used. There are more large beads and ringlets, and no more metapodials sawed into slices. On the other hand, about 35% of the bone strips were made from *rami horizontali* of cattle-mandibles, more precisely of the parts covering the roots of the molar and premolar teeth (fig. 9: 16-18; fig. 13). Being too thin for the production of beads, mainly ringlets with flat section were made out of these parts (figs. 9, 17: 19-21). The reason for this large scale use of mandibles, that is also found in Strasbourg, is still unclear. Since a maximum of twelve ringlets could be made in this way from one mandible, it will not have enlarged the production much in quantitative respect. However, the acquisition of raw materials could be more systematized this way.

Furthermore the Constance material from the last phase provides indications that a single, simplified, standardized action was constantly repeated during some time by a same person, rather thoughtlessly, like on modern assembly lines. How else can we explain that complete bone strips were drilled from one side, that were far too thin to provide beads; or that a failed large bead (fig. 9: 11) was not only drilled from the second side, where it was clearly visible that no good bead could come out anyway, but also polished afterwards, before it finally was thrown away?

So we observe here towards the end of the Middle Ages, the first steps towards a modern way of production. Rationalization and organization of the production process is not a modern or 18th century invention.

As a tentative approach to the development described on the basis of the bonestrips from Constance, the factors raw material supply, demand for products, degree of organization and rationalization of the production process, factors could be combined into an economic model. In the first phase, the demand seems to have been rather small, the raw material supply sufficient and the degree of organization rather low. Roughly around 1400 the demand seems to have grown to such an extent that the raw material supply became less sufficient, apparently not having grown as much. As a consequence the degree of organization seems to have grown. Later, the supply of raw material seems to have been more sufficient again. However, it is not known wether this was caused by a decline in demand or a growth in raw material supply. This remains to be studied. Nevertheless the degree of organization seems to have increased, independently from the stress on raw material supply.

A lot of interesting technical as well as socio-economical information can be deduced from these peculiar bone strips. So far, finds of this type of refuse are known only from north-western Europe.

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