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DENDRODATES OF THREE MEDIEVAL LATRINES OF TARTU

In the article dendrodates of three latrines in Tartu (15 Ülikooli Street, latrines 1b and 5, and 14 Ülikooli Street, latrine 14G-14F) are viewed and they are compared with other archaeological findings. Latrine 1b dates back to the year 1335, latrine 5 to the year 1309 and latrine 14G-14F to the year 1362. The research is unique in northern Europe, because the specifics of medieval waste management are viewed using exact dating. As a result of the research, it was found out that the latrines were used at least 40 years and that the theories of emptying latrines starting not before early modern times are not true.

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Introduction

According to December 2007 data on at least 35 latrines dating to 13th–16th centuries have been found in Tartu (Tvauri & Utt 2007, 143). In addition it has been possible to document several medieval latrines in cultural layer during archaeological supervisions, but at the moment they have not been researched more specifically.

Latrines are one of the most interesting and rich in finds objects in Tartu from the Middle Ages, which posses an enormous scientific value. Although single medieval and newer wood and stone latrines have been researched in other places in Estonia, they have nowhere been found in such large quantity as in Tartu (Bernotas 2007, 54). Latrines of Tartu and material discovered from them have survived remarkably well. The reason is, that in the medieval position of the town on Emajõgi flood plain the soil is wet all year round because of ground water coming from Quaternary deposits. Moisture is in turn a perfect preservative for organics, especially in lower levels of the cultural layer (Metsallik 1985, 47 ff.).

In Estonia the dendrochronological dating of wood structures has been researched by Tartu University lecturer Alar Läänelaid (Läänelaid & Eckstein 2003; Läänelaid 2004; 2005; 2006; Läänelaid et al. 2005), who has also dated

the wooden floats below St. John's Church walls (Läänelaid 2002). The objective of the current article is to publish dendrodates of three different Tartu latrines and compare their suitability with archaeological findings. It is the first research in northern Europe where medieval latrines have been examined with exact science method.

For dating, the latrines from which the author could take wood proofs himself in 2007 were used. Besides three latrines dated here, more have been discovered on the plots of 14 and 15 Ülikooli Street, but they have not survived well enough – they were made of either too thin or trimmed logs or it was not possible to dig them out to a full extent.

Dated latrines

15 Ülikooli Street courtyard, latrine 1b

The plot in 15 Ülikooli Street was situated right in the centre of Tartu surrounded by town wall, on the east side of Mary Church, which was the largest sanctuary in Tartu (Fig. 1). Latrine 1b is one of six latrines examined in courtyard

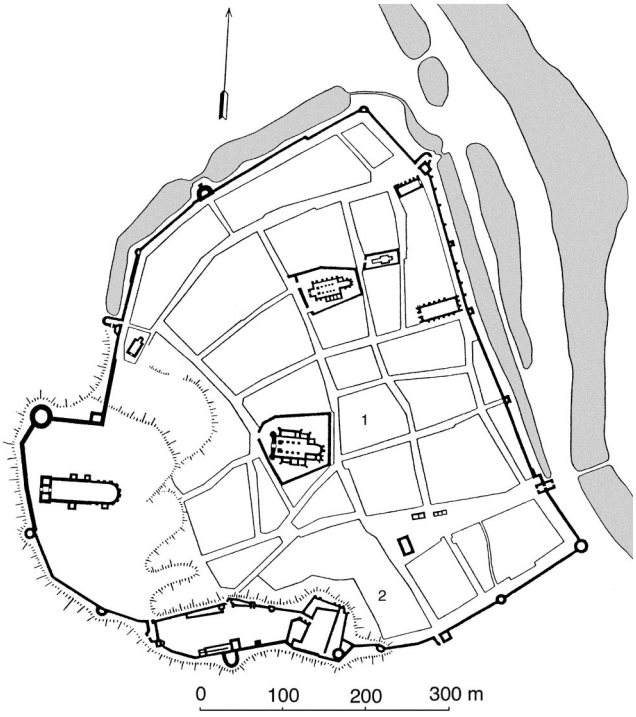

Fig. 1. Location of investigated latrines on the map of medieval Tartu. 1 Courtyard of 15 Ülikooli St., 2 Plot of 14 Ülikooli St. Drawing by Andres Tvauri.

of 15 Ülikooli Street in 2005 and 2007. The content of only two of those latrines (Nos 1b and 6) was completely excavated. Other latrines had been destroyed before the archaeological research (latrine No 3) or they were below the appointed digging depth and only their upper part could be examined (Tvauri 2007).

The side length of the quadratic corner-jointed log box (Fig. 2) measured from inside was 1.8 m. The box has been at least 15 log-levels high (1.9 m). Logs had been connected with dog-neck type connection, whereas the hollow of the corner tenon was hewed on the upper side of a log. As on some parts the bark is visible, it can be concluded that they were pine logs. The logs were 10 cm in diameter on an average. The box was surrounded by medieval cultural layer composed of loafs, branches, leather and other organic waste. Below the box the layer of decomposed peat emerged, into which the lowest log layer had sunk. Box 1b had been built inside a former and larger latrine (1a) (Tvauri 2007, 12).

Inside the box, 1–2 log layers from above, there was a thin wood line, which seemed to originate from north–south directed boards. Below that line the box was filled in with thick and soggy, green-brown or dark-red organic layer, which contained branches, chips, cherry stones, parts of wooden tableware, ceramics and other findings. In addition there were many large bricks in the latrine (size 30.5–31.5 × 14.5–15.5 × 8–10 cm) and their parts. Bricks were in most cases with grout traces. There was a pile of land stones on the bottom of the box (Tvauri 2007, 12).

Fig. 2. 15 Ülikooli St. latrine 1b. Photo by Andres Tvauri.

The substance in the latrine was mainly dated from the period starting from the mid-14th century until the end of the 14th century (Tvauri & Utt 2007, 144 f.).

15 Ülikooli Street courtyard, latrine 5

Latrine No 5 (Fig. 3) was situated on the east side of latrine 1b. From that only the logs covering the box could be cleaned and also the box of four highest log layers. Up to that height the box was filled in with later material. It was not possible to observe the initial content of the box – it was below the digging depth and will be conserved below the concrete floor of the cellar. From the stratigraphical location the box clearly dated from the Middle Ages, being on the same level and in the same direction with box 1b and surrounded with medieval cultural layer (Tvauri 2007, 14 f.).

The box was built of an average 15-cm-thick round pine logs. Logs were attached to each other with dog-neck tenon. The internal measures of the box were 1.4 m from east to west and at least 1.3 m from north to south. The latter measure could not be determined more precisely, as the upper part was probably destroyed with installing a wooden drain well in the 18th century (Tvauri 2007, 14 f.).

Fig. 3. 15 Ülikooli St. latrine 5. Photo by Andres Tvauri.

On the box, seven from east to west directed round logs with a diameter of around 24 cm were laid. In the middle of the box there was a two-log wide opening in the log layer. Probably the log layer was the cover of latrine (Tvauri 2007, 14 f.). From those log layers the samples for dendrodating were taken – the upper layers of the box were too rotten to use them for dating.

14 Ülikooli Street courtyard, latrine 14G-14F

The plot on 14 Ülikooli Street was situated in the southern part of medieval Tartu, surrounded with the town wall, just on the foothill of medieval bishop's castle (Fig. 1). The latrine that was situated in squares 14G-14F (Fig. 4) in the grid formed in pit was excavated by archaeologist Peeter Piirits in 2007. The length of the box was 3 m and the width ca. 1.5 m. It was made of 20 cm thick pine logs and was limed from inside. The box had survived at the eight of nine log layers (2 m).

The interior of the latrine was filled in with dark and thick organics-rich manure layer, which included pieces of wooden tableware and ceramics, fragments of textile, pieces of glass, metal parts, etc. (Piirits 2008). The findings date back to the 15th century. For instance, there was an oval so-called Jacoba jug (Fig. 5), which had been manufactured in Waldenburg, western Saxonia (Russow 2006, 101, fig. 28: 1).

Fig. 4. 14 Ülikooli St. latrine 14G-14F. Photo by Rivo Bernotas.

Fig. 5. Jacoba jug, found from latrine 14G-14F of 14 Ülikooli St. (TM A 133: 4264: 1, 2). Photo by Rivo Bernotas.

In addition, two stoneware jars of Siegburg origin were found as well (see Russow 2006, fig. 12: 8) and a jar from Waldenburg (TM A 133: 4244), which all date back to the 15th century (written note from Erki Russow, February 2008).

Dendrodating methodology

According to the methodology currently in practice in Europe, wooden structures are dated using the width of rows of average annual tree rings, taken preferably from at least ten different log samples. In order to achieve sufficient reliability, the logs must be long enough, about 100 years old, but in some cases 50–60 years. To assess the similarity and reliability of the rows, the *Student t*-value is used as parametric methods, and a so-called sign-test as non-parametric methods. *Student t*-value is calculated from the correlation coefficient and the overlap length of compared the rows. The larger the *t* value is, the more reliably similar the rows are. When comparing hundreds of pairs of numbers, the similarity is considered 95% reliable when *t* is higher than 4. When comparing identical rows the value is $t = 100$. In practice the value of *t* is calculated using different formulas in computer programs and that is why its value is a bit vary (Sander & Levanic 1996, 269 ff.).

Sign test (*Gleichläufigkeit*) gives the percent of same direction changes (increase or decrease) in the width of the neighbouring tree rings in two compared rows (Kaennel & Schweingruber 1995, 162). When the growth (width of annual ring) decreases in both ring-widths' series put beside each other, then it is considered to be one similarity point. When in both rows the growth is higher next year, then this also gives one similarity point. When one of the year ring widths remains unchanged, then this gives half a point. When counting the points for the same direction changes and dividing the sum with the sum of total changes (length of compared rows' overlap) ratio *W* is obtained *(Gleichläufigkeit)*. Depending on the length of the rows the program also gives confidence level, on which the calculated *W* is reliable (0.95; 0.99 or 0.999). Sign test is used beside *Student t-value* (Läänelaid 1999, 142).

In order to measure and date samples, well-known dendrochronology programs in Europe, such as TSAP (Time Series Analysis) (Rinntech) and CATRAS (Computer Aided Tree Ring Analysis System), were used (Aniol 1983, 46).

Dating Tartu latrines

From the logs of all the latrines in question, we sawed test discs with Andres Tvauri. From latrine 1b 41 different wood discs were sawn for dating. Proofs could be taken from the logs of all four sides, but they could not be taken from the lowest layers due to the active inflow of water. From the samples, 23 ring width series were averaged to a 79 year long average *1epy1501* and the average was compared with chronologies (or series) from Stockholm (3spsto09, t = 4.07, W = 66.7), Uppland (3spupp01, t = 3.83, W = 61.5) and 12 samples from Vene Street in Tallinn (3epv1201, t = 3.8, W = 61.5). In addition, four sample series were averaged to a 123 year long average 1epy1511 and compared first of all with 15 Ülikooli Street sample series 1epy1501 (t = 5.89, W = 71.2) and then with 14 Ülikooli Street latrine sample series 1epy1406 (t = 4.26, W = 63.9) and series from Kuldjala tower (3epyklj02, t = 4.36, W = 54.5). All comparisons unambiguously date last year circle to year 1335 (Fig. 6).

From latrine No 5 samples were taken from all four widest cover logs. As there were only four samples, the expectations for dating success were low. Still series of two samples could be averaged to 86 year long average 1epy15k1. When comparing the average with chronologies from Novgorod (3rpnov05, t = 6.28, W = 67.6), Tallinn town hall (3tlr04, t = 5.47, W = 71.2) and Kolm Õde building complex in Tallinn (3ep3od14, t = 4.65, W = 62.4), the result of dating the last ring was 1309 (Fig. 7).

From latrine 14G-14F 13 sample discs were sawed (Fig. 8). Nine of them could be averaged to a 176 year long average 1epy1406. Comparing it with pine chronologies from Gotland (3spgot01, t = 4.11, W = 58.6), Novgorod (3rpnov05, t = 5.44, W = 62.9), Tallinn town hall (3eptlr04, t = 6.51, W = 66.3) and Riga (3lptro01, t = 5.31, W = 68.4), the dendrochronological date was 1362 (Fig. 9).

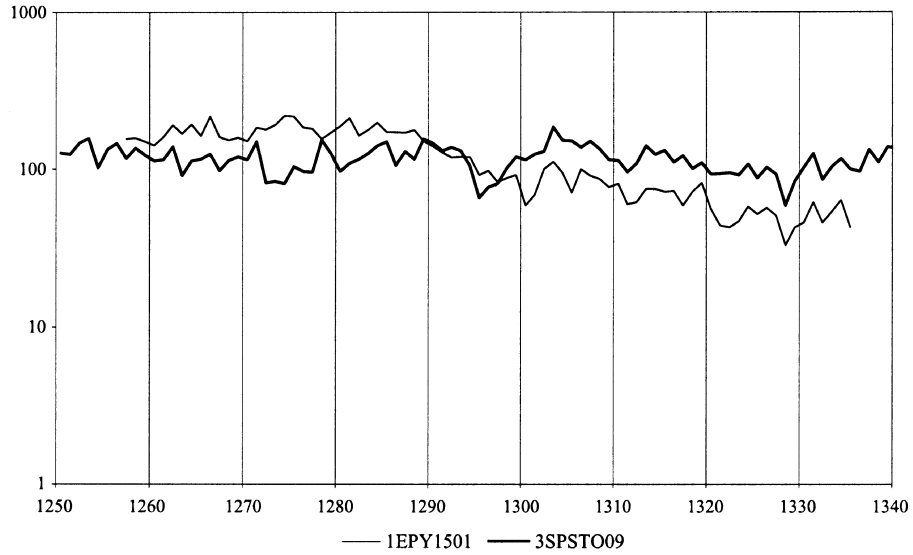

Fig. 6. Average of 23 samples of latrine 1b from 15 Ülikooli Street (1epy1501) in comparison with Stockholm pine chronology (3spsto09). Y-axis marks the width of annual ring and x-axis marks the years.

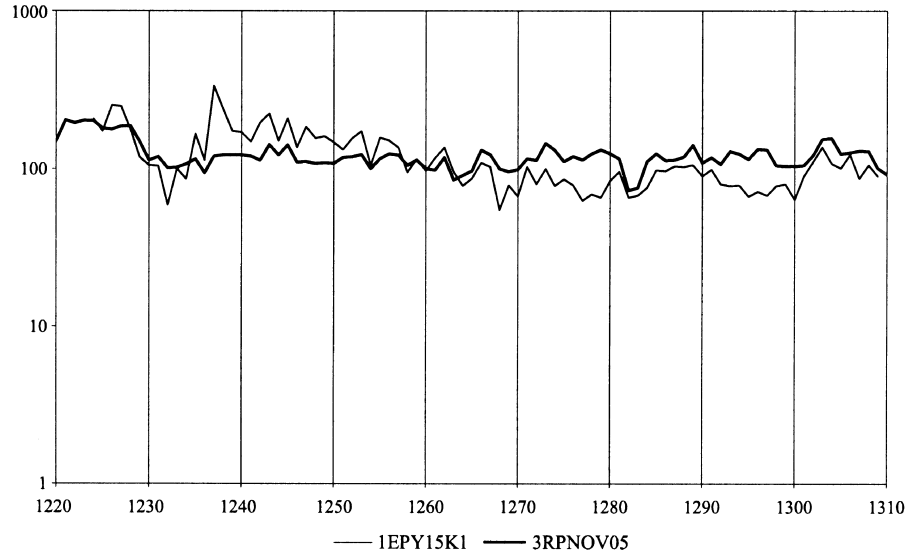

Fig. 7. The average of two samples (1epy15k1) from latrine No 5 at 15 Ülikooli Street in comparison with Novgorod pine chronology (3rpnov05). Y-axis marks the width of annual ring and x-axis marks the years.

Fig. 8. Test discs for dendrochronological dating from latrine 14G-14F of 14 Ülikooli St. Photo by Rivo Bernotas.

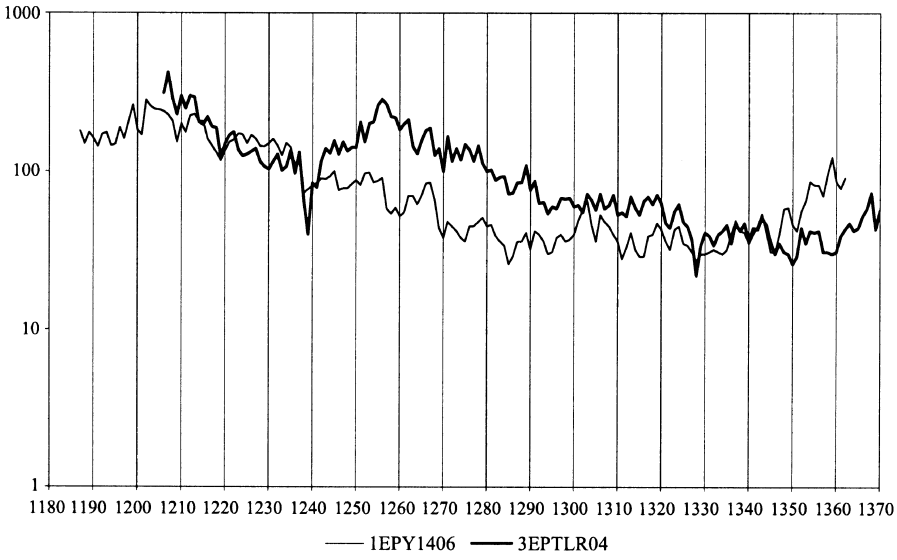

Fig. 9. The average tree ring row of nine samples from latrine 14G-14F at 14 Ülikooli Street (1epy1406) in comparison with average tree ring row of two samples from Tallinn town hall (3eptlr04). Y-axis marks the width of annual rings and x-axis marks the years.

Discussion and results

Dendrochronological dating of wood means determining the growing year of the last measured tree ring. As mentioned, the dates were established using reference chronologies, whereas the correctness of dates was checked using both statistical similarity indicators and visual comparison of figures. As in the case of latrines we are dealing with the dating of round logs, which have bark pieces, then dates show the year of last ring below the bark. The preservation of the last ring below the bark is shown by the same date of different logs in the latrine. After the growth of last annual ring the tree was cut down and used for building the waste pit. The wood was probably not dried before the building of latrines, as they were not quality buildings. New latrines should have got wet from inside and outside. Using raw wood means that the building took place in the year after the year of wood growth at the latest. Derived from the fact that all dates ended with a full tree ring, those trees could be cut from the dendrochronological dating year autumn until spring next year and the building time of latrines evidently falls into the same period.

So far the research of latrines of Tartu has been concentrated on dating and examining their content as separate research complexes (e.g. Mäesalu 1990; Vissak 1994); quite often only most interesting finds from the latrines have been analyzed (Mäesalu 1999; Mäesalu et al. 2008; Tvauri & Utt 2007). The boxes have not been dated with natural science methods. That is why three dendrodates achieved in the current research provide interesting material for further discussion.

One previously unanswered question is: how long were the latrines used before abandoning them, and were they emptied? Using archaeological finds from Tartu latrines it has been thought so far that the boxes most rich in finds are the oldest. For instance Ain Mäesalu, using material from Tartu, has noted that some of the latrines were not emptied during the whole medieval period, and when a box became full then a new one was built beside it. Such activity made the dating of finds from the latrines relatively simple (Mäesalu 2004, 399). It has been assumed that during the building of earlier boxes (those of the 13th–14th centuries), when there was no town wall, there was also no space problem in Tartu. When the box became full, then a new one was built beside it. In the next centuries there was lack of land in the territory surrounded by the town wall due to population growth and the new latrines were regularly emptied and no garbage was thrown into the box that would make it more difficult to empty (Bernotas 2006, 36).

When comparing the dendrochronological dates acquired in the current research with findings, it can be said that already from the beginning of the 14th century the latrines have been built in order to use them repeatedly and theories of emptying the latrines not before the beginning of the modern times are not correct. When looking at latrine 1b dating from 1335 and comparing it with the

chronology of finds (the latest are from the beginning of the 15th century) it can be assumed that the box was in use at least for three quarters of a century.

When comparing the dendrochronological dates of latrine 1b and that of 14G-14F and other finds an interesting connective aspect emerges: in both latrines the first datable finds appear approximately 40 years after the building of the box (latrine 1b was built in 1335 and finds are from the last quarter of the 14th century or from the beginning of the 15th century; latrine 14G-14F was built in 1362 and the earliest findings date to the beginning of the 15th century). That is why it can be suggested that this coincidence is not accidental and that it indicates some kind of (not determined) system in medieval waste management.

The German researcher Manfred Gläser has written about the latrines 6 metres in diameter and 8 metres in depth discovered in Lübeck, which in his opinion without emptying became full in 30–50 years (Gläser 1999, 32). Taking into account the several times smaller size of Tartu dendrodated latrines it can be assumed that they were used at least for 40 years in which time they were constantly emptied. The question why they were no longer emptied and why the dates of the last components found in the boxes were as described, demands further research.

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Rivo Bernotas

TARTU KOLME KESKAEGSE JÄÄTMEKASTI DENDRODATEERINGUD

Resümee

Tartust on 2007. aasta detsembri seisuga leitud vähemalt 35 13.–16. sajandisse kuuluvat jäätmekasti ehk latriini. Lisaks on dokumenteeritud mitmeid keskaegseid jäätmekaste, kuid esialgu on need veel läbi uurimata. Jäätmekastide näol on tegemist ühtede kõige leiurikkamate ja huvitavamate keskaegsest Tartust säilinud objektidega, mille teaduslik väärtus on hindamatu. Ehkki üksikuid kesk- ja uusaegseid puidust ning kivist jäätmekaste on uuritud ka mujal Eestis, pole neid kusagilt leitud nii arvukalt kui Tartust. Tartu jäätmekastid ja neist avastatud leiumaterjal on tänu Emajõe niiskusrežiimile erakordselt hästi säilinud.

Eestis on puitrajatiste dendrokronoloogilise dateerimisega seni tegelnud Tartu Ülikooli geograafia instituudi lektor Alar Läänelaid. Käesoleva artikli eesmärgiks on publitseerida kolme erineva Tartu jäätmekasti dendrodateering ja võrrelda nende sobivust arheoloogilise leiumaterjaliga. Tegemist on esimese uurimusega Põhja-Euroopas, kus keskaegseid jäätmekaste on uuritud täppisteadusliku meetodi abil.

Dateeritud jäätmekastideks on Ülikooli 15 jäätmekastid 1b ja 5 ning Ülikooli 14 jäätmekast 14G-14F. Ülikooli 15 jäätmekastist 1b saadud leiuaines pärineb peamiselt perioodist 14. sajandi keskpaigast kuni 14.–15. sajandi vahetuseni; Ülikooli 15 jäätmekastist 5 leiumaterjali ei saadud ja Ülikooli 14 jäätmekasti 14G-14F leiumaterjal kuulub 15. sajandisse.

Praeguse Euroopas praktiseeritava metoodika kohaselt dateeritakse puitrajatisi mitme, soovitatavalt kümmekonnast eri palgist võetud puiduproovi keskmiste aastarõnga laiuste ridade abil. Võrreldavate ridade sarnasuse küllaldase usaldatavuse saavutamiseks peavad read olema piisavalt pikad, soovitatavalt sadakonna, mõnel juhul siiski ka 50–60 aasta pikkused. Ridade sarnasuse ja usaldatavuse hindamiseks on parameetrilistest meetoditest kasutusel *Student t*-väärtus ning mitteparameetrilistest meetoditest nn märgitest. Proovide mõõtmiseks ja dateerimiseks on dendrokronoloogias kasutatud Euroopas laialdaselt levinud arvutiprogramme TSAP (Time Series Analysis) (Rinntech) ja CATRAS (*Computer Aided Tree Ring Analysis System*). Ülikooli 15 jäätmekast 1b õnnestus dateerida 1335., Ülikooli 15 jäätmekast 5 1309. ja Ülikooli 14 jäätmekast 14G-14F 1362. aastaga.

Puidu dendrokronoloogiline dateering tähendab sellest puiduproovist mõõdetud kõige viimase aastarõnga kasvamise kalendriaastat. Nagu eelnevast nähtub, tehti dateeringud kindlaks võrdluskronoloogiate abil, kusjuures dateeringute õigsust kontrolliti nii statistiliste sarnasusnäitajate kui ka graafikute abil. Kuna uuritud jäätmekastide puhul oli tegemist ümarpalkide dateerimisega, millel oli säilinud ka kooretükke, siis näitavad dateeringud viimase koorealuse aastarõnga kalendriaastat. Viimase koorealuse aastarõnga säilimist osutab ka sama jäätmekasti eri palkide sama dateering. Viimaseks jäänud aastarõnga kasvamise järel puud langetati ja kasutati jäätmekastide ehitamiseks. Võib oletada, et jäätmekastide ehitamiseks puitu eelnevalt ei kuivatatud, kuna tegemist ei olnud kvaliteetehitistega. Vastsed jäätmekastid pidid nii väljast- kui seestpoolt niikuinii taas märjaks saama. Toore puidu kasutamise eeldamine tähendab ehitusaega hiljemalt järgmisel kalendriaastal pärast viimase aastarõnga kasvamist. Tulenevalt asjaolust, et kõik dateeritud proovid lõppesid täisaastarõngaga, võidi need puud langetada ajavahemikus dendrokronoloogilise dateeringu aasta sügisest kuni järgmise aasta kevadeni ja samasse perioodi jääb tõenäoliselt ka jäätmekastide ehitamisaeg.

Tartu keskaegsete jäätmekastide uurimine on seni keskendunud nende sisu kui suletud leiukomplekside uurimisele ja dateerimisele või siis on käsitletud kastidest leitud uhkemaid leide. Kaste endid pole seni loodusteaduslike meetoditega dateerida õnnestunud. Seega pakuvad käesoleva uurimistöö raames jäätmekastidest saadud kolm dendrodateeringut põnevat mõtteainest.

Üks seni vastuseta olnud küsimus on: kui kaua kaste enne nende hülgamist kasutati ja kas neid ka tühjendati? Tartu jäätmekastide puhul on siiani arheoloogilisele leiumaterjalile tuginedes arvatud, et kõige leiurikkamad kastid on ühtlasi ka dateeringutelt kõige varasemad. Näiteks Ain Mäesalu on Tartu materjali uurides täheldanud, et osa kastidest ei tühjendatud kogu keskaja jooksul, vaid kui jäätmekast täitus, ehitati selle lähedusse uus. Selline teguviis muutis vastavatest jäätmekastidest saadavate leiukomplekside dateerimise võrdlemisi lihtsaks. On oletatud, et varasemate kastide ehitamise ajal (13.–14. sajandil), kui puudus veel linnamüür, ei olnud Tartus ruumikitsikust. Väljakäigu lampkasti täitumise korral rajati eelmise kõrvale uus. Hilisematel sajanditel tekkis linnamüüriga piiratud alal rahvaarvu ja hoonestuse lisandudes tõenäoliselt ruuminappus ning kaste hakati regulaarselt tühjendama ja tühjendamist raskendavat prahti neisse enam ei visatud.

Vaadeldes käesoleva uurimuse käigus saadud dendrokronoloogilisi dateeringuid ja kõrvutades neid leiumaterjaliga, võib kindlalt väita, et juba 14. sajandi esimesest poolest on jäätmekaste ehitatud eesmärgiga kasutada neid korduvalt ning varasemad, kastide tühjendamist alles varauusajast alates toetavad seisukohad pole tõesed. Vaadeldes näiteks Ülikooli 15 jäätmekasti 1b dateeringut 1335. aastal ja võrreldes seda leiumaterjali dateeringutega (hiliseimad leiud pärinevad 15. sajandi algusest), võime kindlalt väita, et see oli kasutuses vähemalt kolmveerand sajandit.

Võrreldes Ülikooli 15 jäätmekasti 1b ja Ülikooli 14 jäätmekasti 14G-14F dendrokronoloogilisi dateeringuid ning leiumaterjali, tuleb välja mõlemaid objekte ühendav huvitav nüanss: mõlemas jäätmekastis tekivad esimesed dateeritavad leiud orienteeruvalt 40 aastat pärast kasti ehitusaega (Ülikooli 15 jäätmekast 1b ehitati 1335. aastal ja leiumaterjal pärineb valdavalt 14. sajandi viimasest veerandist või 15. sajandi algusest; Ülikooli 14 jäätmekast 14G-14F ehitati 1362. aastal ja leiumaterjal kuulub kõige varasemalt 15. sajandi algusse). Seega võib oletada, et see kokkulangevus pole juhuslik, vaid viitab mingile seni kindlaks tegemata süsteemsusele keskaegses jäätmemajanduses. Küsimus, miks jäätmekaste edasi ei tühjendatud ja viimastesse kastidesse jäänud leiukomplekside dateeringud on just sellised, nagu need on, ootab edaspidist lahendamist.