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THE POTTERY FINDS FROM THE WESTERN *CANABAE LEGIONIS* AT NIJMEGEN (NL): SOME METHODS FOR SPATIAL AND CHRONOLOGICAL ANALYSIS

Introduction

In 1987–1997 Radboud University has carried out a large excavation in the eastern part of Nijmegen, on the site of the Canisiuscollege, a former boarding school (**fig. 1**).[1] In the excavated area, measuring c. 3.5 ha, remains of three archaeological complexes have been uncovered:

– a 42 ha large military base from the Augustan period (**fig. 2,4**);
– a pre-Flavian cemetery (**fig. 2,3**) belonging to the civil settlement identified with *Oppidum Batavorum* (**fig. 2,1**);
– the *canabae legionis* (**fig. 2,D**) surrounding the legionary fortress of *Legio X Gemina* and its successors (**fig. 2,C**), dated to the Flavian period and 2nd century.

The Augustan military base and the pre-Flavian cemetery will not be discussed here. Their remains were overbuilt by various structures of the *canabae legionis*, the most conspicuous of which are timber and stone buildings and several bundles of ditches (**fig. 3**). Furthermore two pottery kilns deserve special mention (**fig. 3,a–b**).

The Canisiuscollege excavation has produced vast amounts of finds, which have been classified during and after the field work by the late Jan Kees Haalebos. The finds database records over half a million pottery fragments and other objects (**table 1**). Although various finds groups have been studied in the past, mainly by students and PhD students, relatively few results have been published.[2] In 2007 the analysis of the features of the Augustan military base was resumed, and in 2012 the study of the finds from the Flavian and later *canabae legionis*.[3]

The analysis of hundreds of thousands of finds is quite challenging. On the one hand such quantities are difficult to master, but on the other hand they represent an enormous research potential. In finds groups of this size trends and patterns may be detected which remain invisible in smaller samples.

The excavated area of the *canabae legionis* appears to have been inhabited from its foundation shortly after AD 70 until well after the middle of the 2nd century, but the bulk of the finds predates the departure of *Legio X Gemina* to the Danube around AD 105. From a ceramic point of view a period of no more than 35 years is a fairly short span. There are only few classes of pottery which can be dated within shorter intervals, with terra sigillata as the most prominent example. In the heyday of the *canabae legionis*, the carinated decorated bowl Drag. 29 was succeeded by the hemispherical Drag. 37, with the former type disappearing from the (semi-) military market by AD 85/90.[4] Since similar chronological 'anchors' are rare for this period, any study providing additional chronological grip is very welcome.

Spatial analysis

The large quantities of finds from the Canisiuscollege excavation are reflected by a very dense distribution (**fig. 4**). It is obvious that the finds are not evenly distributed over the excavated area. The southern parts have produced much less objects than the northern ones, but even in the north richer and poorer zones alternate. The attested differences hamper the interpretation of distribution patterns of individual classes of finds. A comparison of two classes of pottery on account of their absolute frequency may well reveal obvious differences (**fig. 5**),[5] but it is difficult to assess the degree of correspondence with the general finds distribution (**fig. 4**).

To answer various questions regarding distribution a grid-based quantitative approach has been developed for the site. A grid of squares measuring 25 × 25 m has been projected on the excavated area (**fig. 6**). The angle of the grid

1 For a concise overview of the 1987–1994 campaigns cf. J. K. Haalebos, Castra und canabae. Ausgrabungen auf dem Hunerberg in Nijmegen, 1987–1994. Libelli Noviomagenses 3 (Nijmegen 1995) (http://repository.ubn.ru.nl/handle/2066/26418). Further interim reports have only been published in Dutch.

2 The major exceptions are Kemmers 2006; S. M. E. van Lith, Römische Glasgefässe aus den westlichen canabae legionis in Nijmegen. Gesamtkatalog der Ausgrabungen 1987–1997. Kölner Jahrb. 39, 2006, 111–202. Cf. Kloosterman/Polak/Zandstra 2014, 36–38 for an overview of other studies.

3 For the Augustan base cf. R. A. J. Niemeijer, Die westlichen Wehranlagen des augusteischen Lagers auf dem Humerberg in Nijmegen. Die Ausgrabungen der Radboud Universiteit 1987–1997. Kölner Jahrb. 46, 2013, 35–74; id., Das Tafelgeschir aus dem grossen augusteischen Lager auf dem Hunerberg in Nijmegen. Die Ausgrabungen der Radboud Universiteit 1987–1997. Kölner Jahrb. 47, 2014, 7–40. – For the *canabae legionis* cf. Kloosterman/Polak/Zandstra 2014; see also R. Kloosterman, Nijmegen-Holdeurn ware from the western *canabae legionis* at Nijmegen (NL) (in this volume).

4 E.g. A.W. Mees, Modelsignierte Dekorationen auf südgallischer Terra Sigillata. Forsch. u. Ber. Vor- u. Frühgesch. Baden-Württemberg 54 (Stuttgart 1995) 55–59; M. Polak, South Gaulish terra sigillata with potters' stamps from Vechten. RCRF Acta Suppl. 9 (Nijmegen 2000) 125.

5 For the two local fabrics of colour-coated ware cf. R. Kloosterman in: Kloosterman/Polak/Zandstra 2014, 65–135.

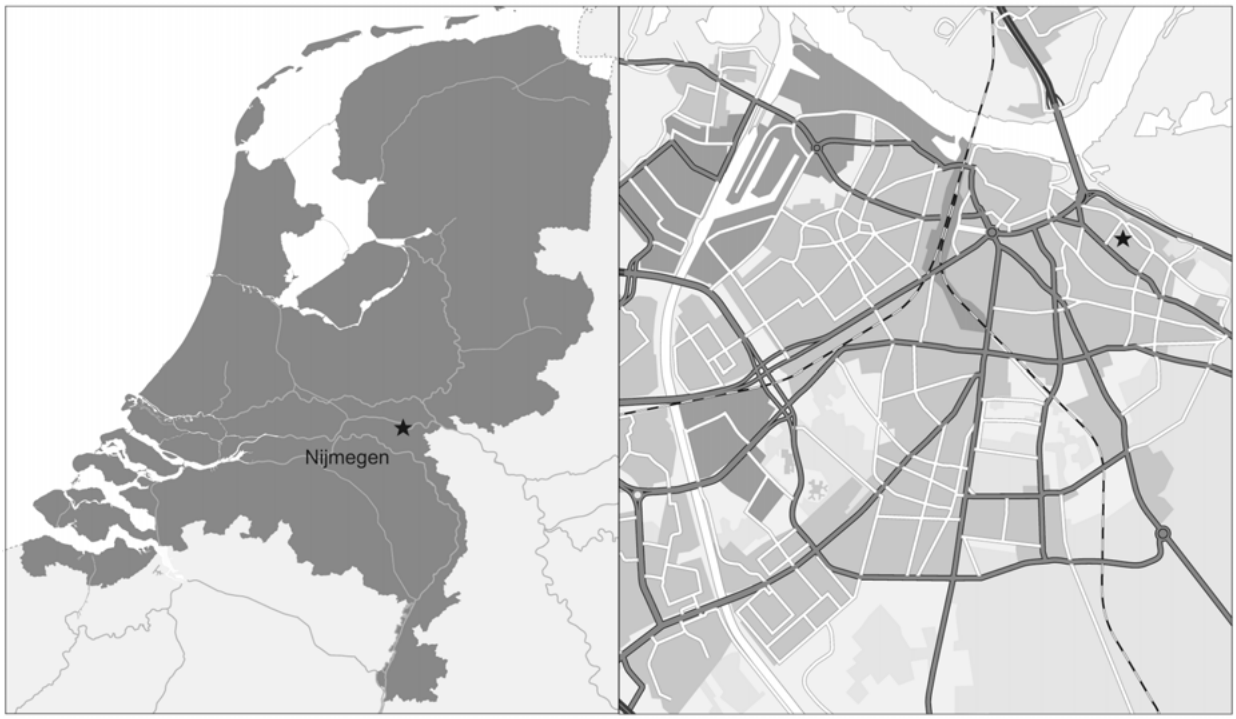

Fig. 1. Location of the Canisiuscollege excavation at Nijmegen, indicated with a star.

Fig. 2. Location of the main archaeological complexes at Nijmegen, from the early and middle Roman periods. The Canisiuscollege excavation is indicated with a star. Early Roman period (dashed lines): **1** civil settlement *Oppidum Batavorum*; **2** Trajanusplein fort; **3** pre-Flavian cemetery; **4** large Augustan base; **5** Kops Plateau fort. – Middle Roman period (solid lines): **A** civil town *(Ulpia) Noviomagus*; **B** town cemetery; **C** legionary fortress; **D** *canabae legionis*; **E** fortress/*canabae* cemetery. – Base map: Lidar-based digital elevation model AHN2 (Actueel Hoogtebestand Nederland, http://www.ahn.nl). Locations after Van Enckevort/Heirbaut 2010 figs 29 and 151, with adaptations.

Fig. 3. Nijmegen, excavation Canisiuscollege: survey of the major features. – Scale 1:2,000.

finds group	rims	walls	bases	sherds	mni	records
prehistoric pottery	56	122	12	190	12	81
terra sigillata	12,705	11,803	5,506	30,013	853	17,424
thin-walled pottery	293	1,938	165	2,396	17	661
colour-coated wares	4,889	16,524	2,531	23,944	322	10,318
Gallo-Belgic wares	4,635	9,005	1,521	15,161	160	7,366
oxidised wares (excl. coarse-tempered)	7,016	129,117	8,274	144,405	145	17,225
amphorae, dolia, mortaria	7,874	49,367	2,532	59,772	193	16,695
coarse wares (mainly reduced)	21,567	65,797	8,437	95,801	549	16,18
Nijmegen-Holdeurn ware	19,113	60,972	9,206	89,291	803	22,206
handmade pottery	673	5,762	256	6,691	27	2,105
wasters	0	52	4	56	0	7
post-Roman pottery	252	651	107	1,01	10	711
other pottery	1	0	1	2	1	2
glass	1,194	5,601	661	7,456	221	3,404
metal	42,546	2,811	237	45,558	36,213	17,541
bricks and tiles	1,432	1,593	4	3,029	280	2,083
stone	255	803	2	1,06	75	844
organic matters	1,468	438	199	2,105	413	2,347
various	9	11	0	20	1	30
unknown	0	0	0	0	0	1
other	0	1	0	1	0	1
sum	**125,978**	**362,368**	**39,655**	**527,961**	**40,295**	**137,232**

Table 1. Overview of the pottery finds from the Canisiuscollege excavation at Nijmegen.

Fig. 4. Nijmegen, excavation Canisiuscollege: distribution of all the finds attributed to features.

Fig. 5. Nijmegen, excavation Canisiuscollege: comparison of the distribution of two local fabrics of colour-coated ware.

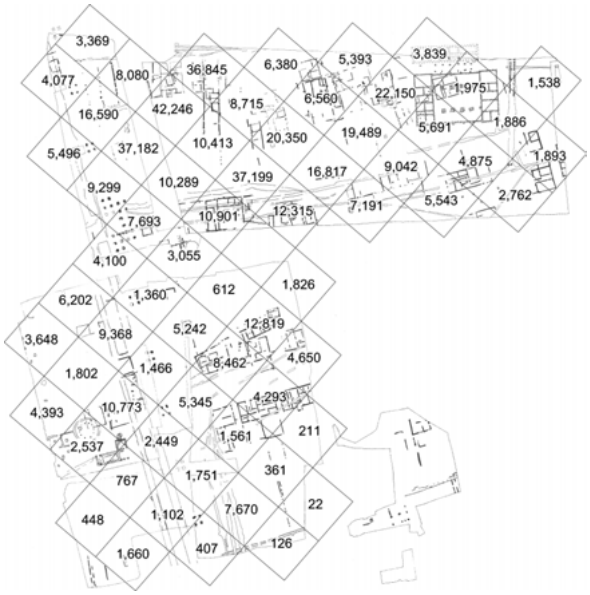

Fig. 6. Nijmegen, excavation Canisiuscollege: grid of squares of 25 × 25 m projected on a simplified map of the main excavated features, with absolute numbers of finds per square.

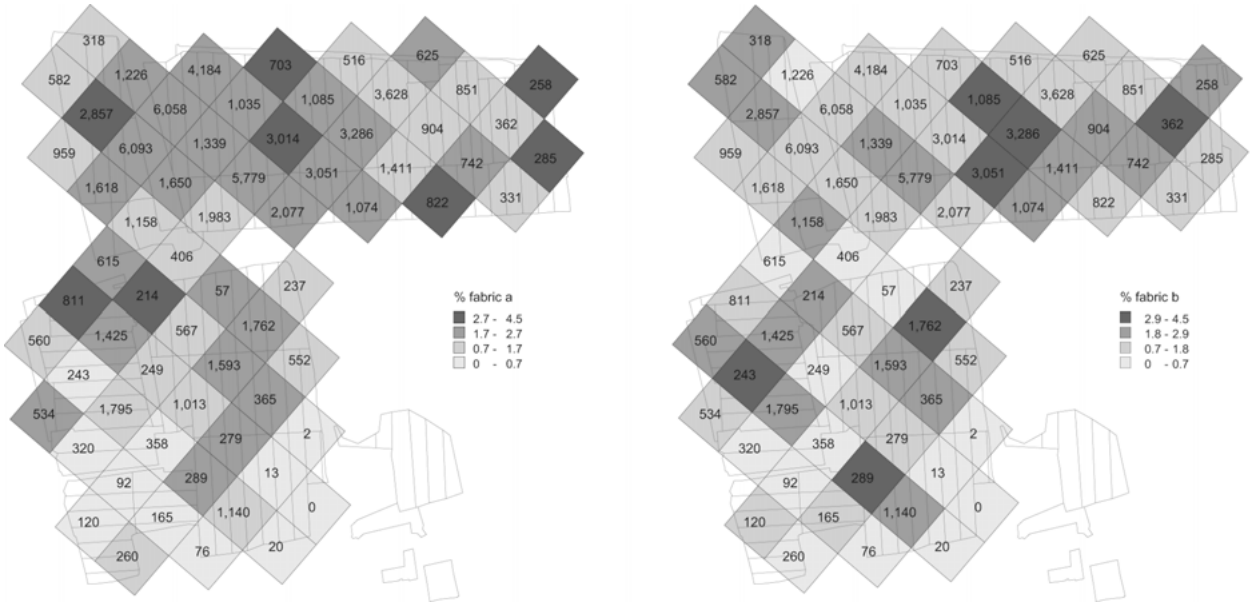

Fig. 7. Nijmegen, excavation Canisiuscollege: distribution of colour-coated ware in the non-local fabrics a and b.

does not align with the orientation of either the excavation trenches or the excavated buildings and other structures. Any category of finds can be quantified per square of 25 × 25 m. The total number of finds per square varies from 22 to more than 40,000, with most squares containing more than 1,000 objects. The application of smaller squares might produce more subtle distribution patterns, but the resulting lower numbers of finds per square would have a negative influence on statistical reliability and significance.

The grid-based approach permits the calculation of the ratio between a particular group of finds and a larger relevant group. The shares of two non-local fabrics of colour-coated ware in the entire ceramic assemblage have been illustrated here as an example (**fig. 7**).[6] For each square the number of colour-coated rim fragments has been expressed as a percentage of the rim fragments of all the pottery found in that square. The numbers indicated in the squares represent the absolute numbers of rim fragments of all pottery, while the shares of the two fabrics of colour-coated ware have been divided into four classes, each represented by a different colour. In the two darkest classes of squares the percentages are above

[6] For the definition of fabrics a and b cf. H. Brunsting, Het grafveld onder Hees bij Nijmegen Nijmegen. Een bijdrage tot de kennis van Ulpia Noviomagus. Arch.-Hist. Bijdragen, 4 (Amsterdam 1937) 70–71.

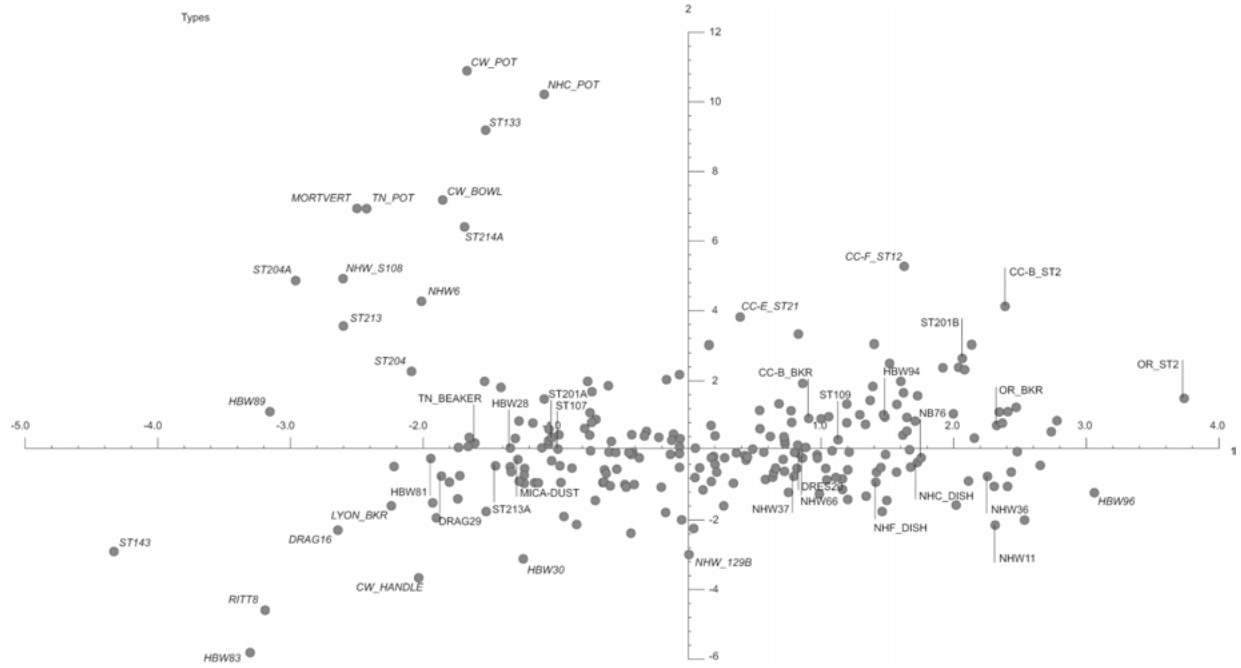

Fig. 8. Nijmegen, excavation Canisiuscollege: results of a correspondence analysis of 895 features with 231 pottery types, showing the distribution of the types.
Abbreviations used in the labels: BKR beaker, CC colour-coated ware, CW coarse ware, DRAG Dragendorff, DRES Dressel, HBW Holwerda Gallo-Belgic ware, LYON colour-coated ware in Lyon fabric, NB Niederbieber, NHC/NHF/NHW Nijmegen Holdeurn ware (coarse, fine, unspecified), OR colour-coated ware in local orange fabric, RITT Ritterling, ST Stuart, TN terra nigra.

the average of the fabric group, in the two lightest classes of squares they are below the group average.[7] Clearly, the highs and lows of the two fabrics have different distributions. The differences align with the general occupation history of the site, as will be elucidated at the end of this paper.

Chronological analysis

As mentioned earlier, most of the pottery vessels have been discarded during the floruit of the *canabae legionis* c. AD 70–105. It is likely that early and late deposits differ in the pottery groups and vessel types represented, e.g. in the amounts of the decorated terra sigillata bowls Drag. 29 and 37 with their divergent date ranges. Other classes of pottery and vessel types may also have been subject to changes during this time span.

Obviously, powerful tools are required to explore a dataset including over 1,300 unique combinations of fabrics and types and over 2,700 separate archaeological features related to the *canabae legionis*. Correspondence analysis is a very suitable statistical method for the detection and visualisation of patterns in such large and complex datasets.[8] The method calculates the optimal order – that is to say optimal from a mathematical viewpoint! – of the data, based on the distribution of the pottery classes over the archaeological features. There is no warrant, however, that the mathematically optimal order makes sense from an archaeological point of view.

By merging rare fabrics and minor type variants the 1,300 combinations of pottery fabrics and types from the *canabae legionis* were reduced to 775 combinations, which are called 'types' in correspondence analysis. Most of these 775 'types' are individual vessel types, eventually subdivided per fabric, but some represent groups of vessel types (e.g. mortaria with vertical rims) and fabrics or wares (e.g. mica-dusted ware).[9] To optimise the quality of the analysis 'types' occurring in less than 10 features – which are called 'units' in correspondence analysis – and features containing less than 10 'types' were banned from the analysis. Additionally, a few contexts and 'types' were manually removed from the dataset,[10] after which 895 features and 231 'types' remained, in over 26,000 associations.

Correspondence analysis produces a hierarchy of 'components' expressing a gradually decreasing percentage of the

[7] For those familiar with elementary statistics: the boundaries between the two darkest and the two lightest classes are defined by the standard deviation. For fabric a the average percentage is 1.7 ± 1.1, for fabric b 1.8 ± 1.1.

[8] For the method cf. M. Greenacre, Correspondence analysis in practice[2] (Boca Raton, London, New York. 2007).

[9] Such generic 'types' may result either from the absence of characteristics allowing the attribution to a pottery type or from the merging of rare types and fabrics.

[10] The removed contexts consisted of the two kilns and some associated deposits, which produced enormous quantities of pottery sherds from a limited range of vessel types. The removed 'types' mainly included further unclassified wall sherds of oxidised and coarse wares and of regional and transport amphorae, as these had been handled differently for small and large deposits.

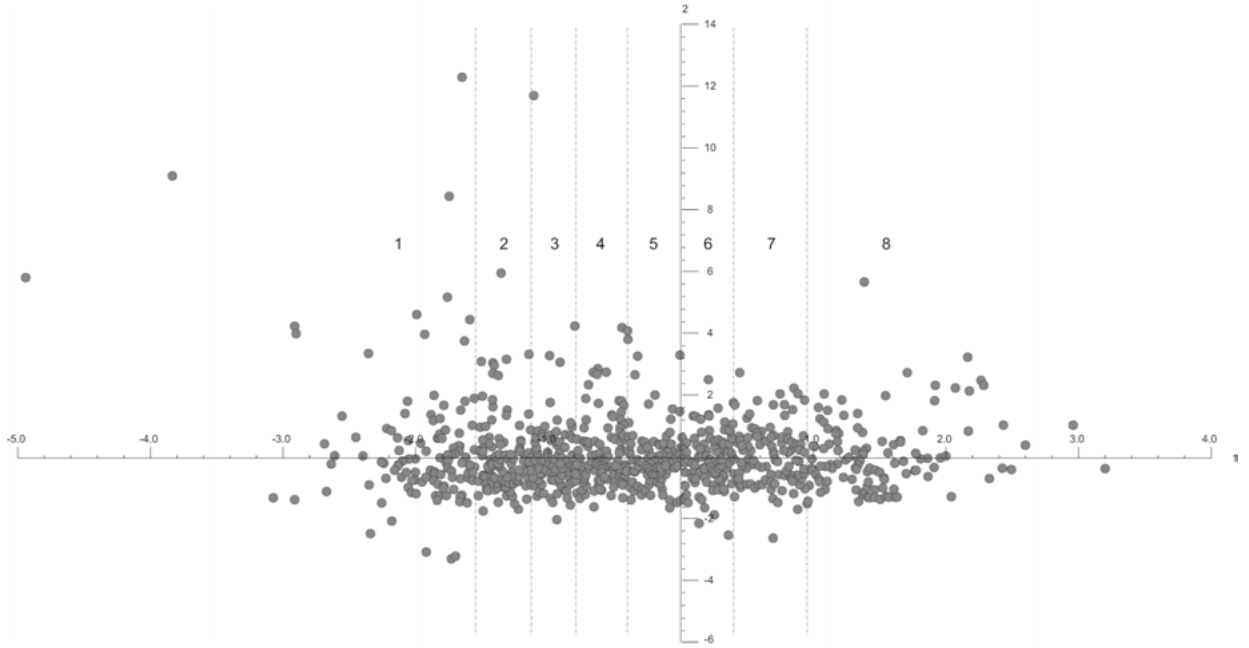

Fig. 9. Nijmegen, excavation Canisiuscollege: results of a correspondence analysis of 895 features with 231 pottery types, showing the distribution of the features. The dashed vertical lines separate eight distinguished groups of features.

variance within the dataset. These components are calculated from the associations of types and units and express the optimal order of both constituents. It is customary to display the first two or three components, in a diagram with two or three axes. Types and units can be either combined in a single graph or divided over two separate diagrams, depending on the number of items. The horizontal axis expresses the largest amount of variance and is therefore the most important.

In the case of the pottery from the Canisiuscollege excavation the first two axes display only 2.8% and 1.6% of the overall variance, which is a reflection of the large size and complexity of the dataset. A superficial inspection of the types diagram (**fig. 8**) reveals that relatively early vessel types occur on the left (e.g. sigillata types Ritt. 8 and Drag. 16) and relatively late types on the right (e.g. colour-coated beakers Stuart 2 in various fabrics and most of the Nijmegen-Holdeurn ware in various types and type groups). The 'types' thus appear to be arranged in a more or less chronological order, from left (early) to right (late).

If the 'types' were to be ordered chronologically, the same should apply to the units or features (**fig. 9**). To test the hypothesis of a chronological order the units have been divided into eight groups of equal size, on account of their position on the horizontal axis.[11] These groups will be mentioned 'CA groups' here, with CA group 1 containing the supposedly earliest features and group 8 the latest ones.

For each class of pottery the distribution over these CA groups can be determined. Diagnostic pottery classes and types like the terra sigillata bowls Drag. 29 and Drag. 37 with their different chronological 'behaviour' have been used to test the hypothesis of a chronological arrangement. The distribution of Drag. 29 and 37 over the eight CA groups is precisely as one might expect in the case of a chronological order: when the sum of both vessel types is set at 100% for each CA group, the share of Drag. 29 steadily decreases from 81-14% while that of Drag. 37 increases from 19-86% (**fig. 10**).[12] That Drag. 29 still occurs in the latest groups is due to residuality rather than an indication of prolonged use into the 2nd century. The hypothesis has been tested with other diagnostic pottery types, and also with dates derived from coins and potters' stamps on terra sigillata, invariably with similar outcomes.[13]

Since more or less 'calibrated' finds groups display a clear chronological distribution over the eight CA groups the distribution of other classes of pottery may therefore be interpreted chronologically as well, with some clearly decreasing over time (**fig. 11**) and others increasing (**fig. 12**). It is not a matter of course, however, that the detected patterns have a universal value. Without further study it cannot be ruled out that the appearance or disappearance of a pottery group at a given time is a local or regional phenomenon and may have occurred earlier or later elsewhere.

[11] The choice of eight groups rests on the assumption that a considerably smaller number would obscure chronological trends, while a considerably larger number would have a negative effect on the statistical reliability of the data per group. Groups 1–7 each contain 29 features and group 8 the remaining 28 out of the grand total of 231 features involved in the analysis.

[12] The percentages are based on the numbers of records in the dataset instead of on the numbers of sherds or vessels, which is associated with certain peculiarities of the recorded data (cf. M. Polak in: Kloosterman/Polak/Zandstra 2014, 30–32).

[13] Cf. M. Polak/R. Kloosterman in: Kloosterman/Polak/Zandstra 2014, 48–63 for a full discussion.

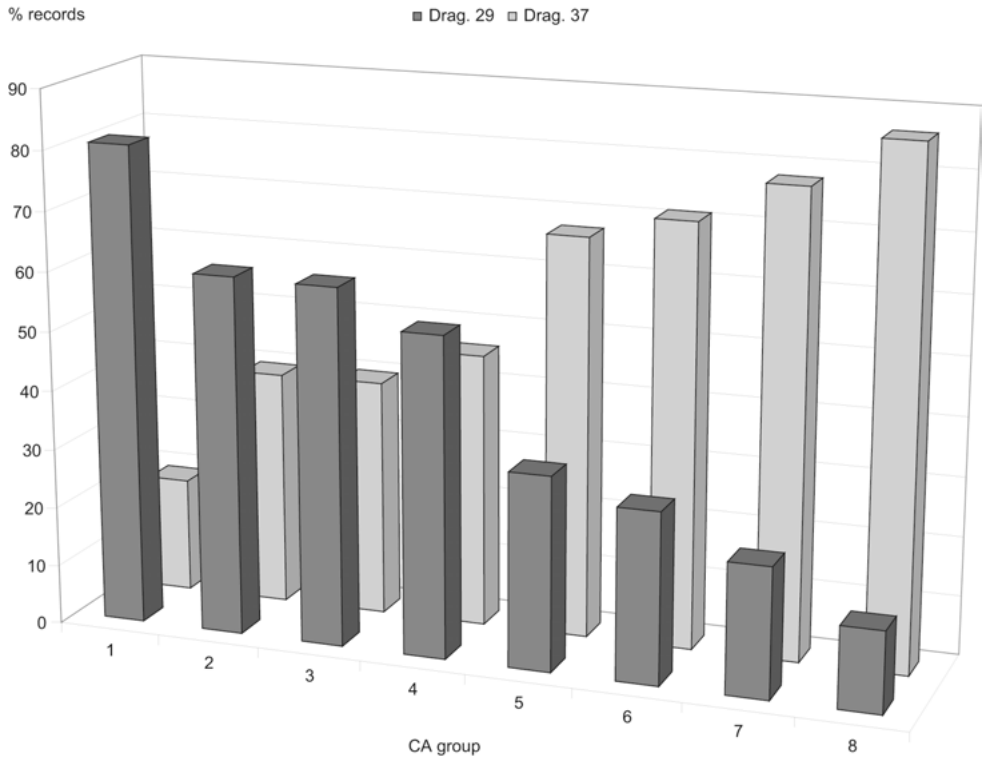

Fig. 10. Nijmegen, excavation Canisiuscollege: shares of the decorated terra sigillata bowls Drag. 29 and 37 in the eight distinguished CA groups.

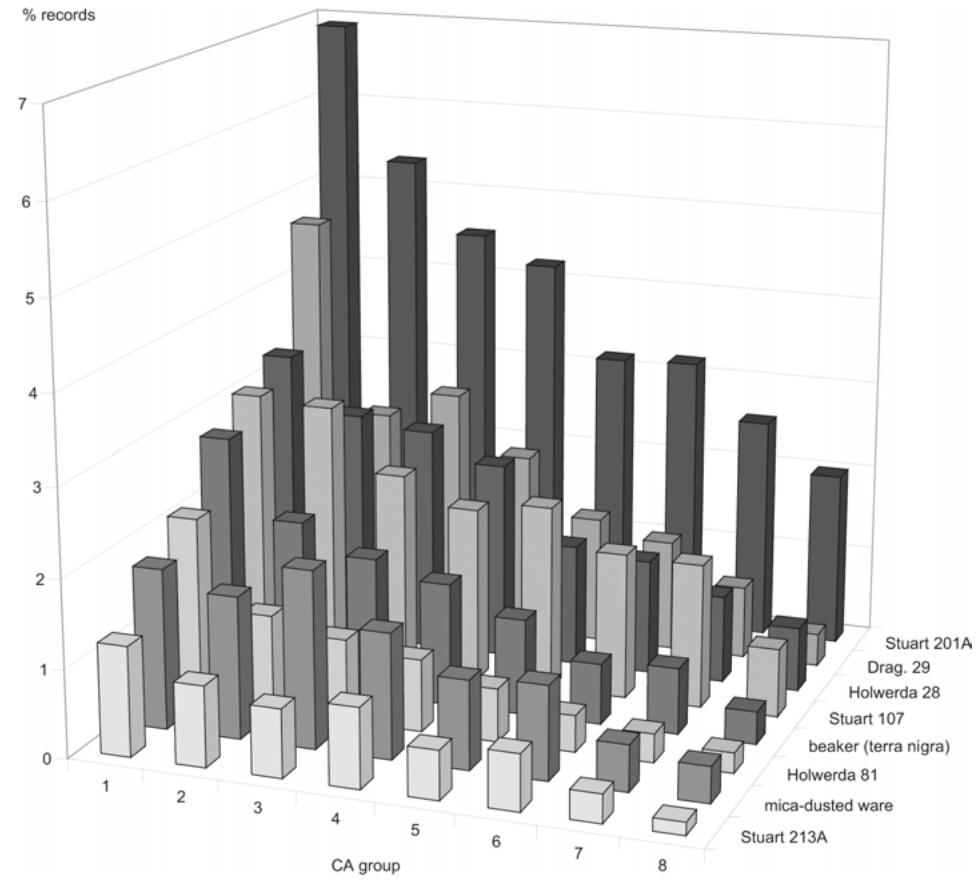

Fig. 11. Nijmegen, excavation Canisiuscollege: eight categories of pottery with frequencies decreasing over the eight distinguished CA groups.

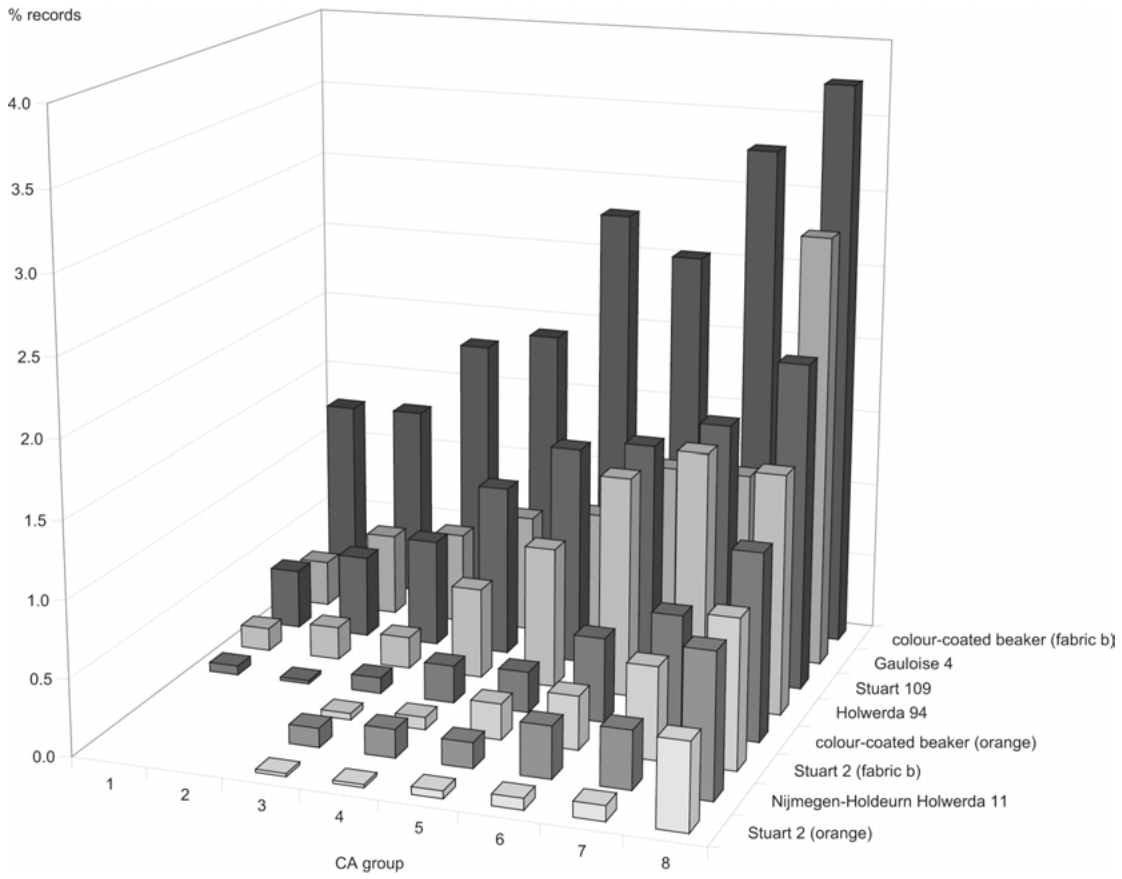

Fig. 12. Nijmegen, excavation Canisiuscollege: eight categories of pottery with frequencies increasing over the eight distinguished CA groups.

Time and space

The constitution of eight chronologically arranged groups of features permits a detailed study of the development of the excavated area of the *canabae legionis*. When the features from each CA group are plotted on the main excavated structures (**fig. 13**) it emerges clearly that the focus of the activities – or, more accurately, of the deposition of the pottery – has gradually shifted from north to south. This tendency has been recognised earlier,[14] but can now be demonstrated in much greater detail.

The differences between the two local fabrics of colour-coated ware illustrated in the earlier section on spatial analysis (**fig. 5**) can now be interpreted. When comparing the distribution of these fabrics with that of the features according to the CA group to which they belong (**fig. 13**), it becomes evident that fabric 'Nijmeegs II' appeared at a somewhat later date than 'Nijmeegs I', on account of its better representation in the southern half of the excavation.[15]

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[14] J. K. Haalebos, Ars cretaria. Nijmegen en La Graufesenque. Enkele gedachten betreffende de organisatie van de terra sigillata-produktie en -handel in La Graufesenque. Libelli Noviomagense 4 (Nijmegen 1997) 8–9 (http://repository.ubn.ru.nl/handle/2066/26426); Kemmers 2006, 111–117; E. van der Linden, Terra sigillata from the Nijmegen canabae legionis (the Netherlands). A chronological and economic perspective. In: B. Liesen (Hrsg.), Terra sigillata in den germanischen Provinzen. Kolloquium Xanten, 13.–14. November 2008. Xantener Ber. 20 (Mainz 2011) 88–90.

[15] This paper is a concise summary of parts of the first two chapters of Kloosterman/Polak/Zandstra 2014, which is only available in the Dutch language. The author is greatly endebted to the two co-authors of that book and to Ryan Niemeijer, who have contributed much to the development of the quantitative approaches outlined here.

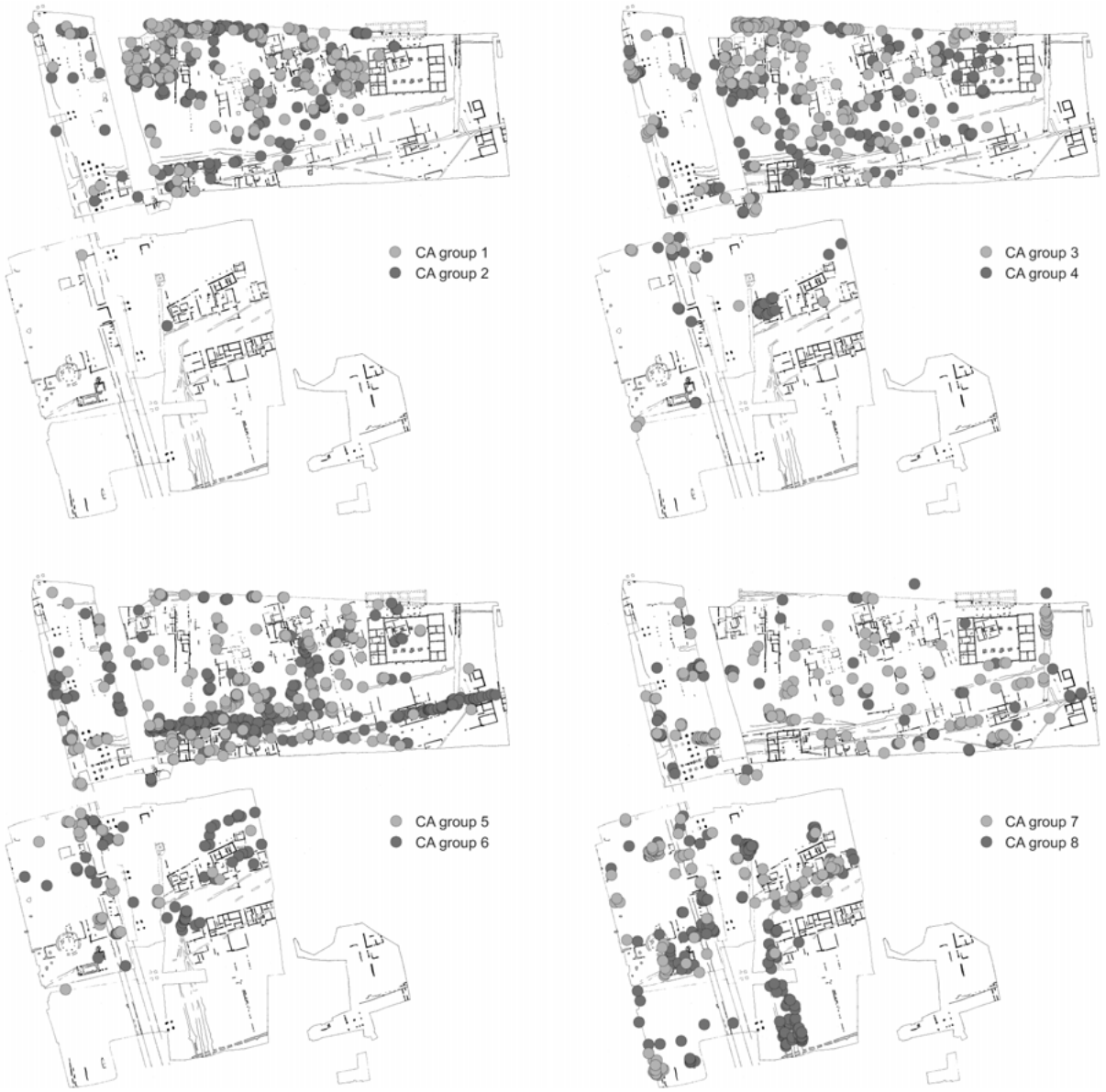

Fig. 13. Nijmegen, excavation Canisiuscollege: spatial distribution of the features from the eight distinguished CA groups.

Bibliography

Kemmers 2006 — F. Kemmers, Coins for a legion. An analysis of the coin finds of the Augustan legionary fortress and Flavian 'canabae legionis' at Nijmegen. Stud. Fundmünzen Antike 21 (Mainz 2006).

Kloosterman/Polak/Zandstra 2014 — R. P. J. Kloosterman/M. Polak/M. Zandstra, Opgravingen op het terrein van het voormalige Canisiuscollege in Nijmegen, 1987–1997. Vondsten uit castra en canabae I. Auxiliaria 14 (Nijmegen 2014) (http://repository.ubn.ru.nl/handle/2066/131835).

Van Enckevort/Heirbaut 2010 — H. Van Enckevort/E. Heirbaut: Opkomst en ondergang van Oppidum Batavorum, hoofdplaats van de Bataven. Opgravingen op de St. Josephhof in Nijmegen 1. Arch. Ber. Nijmegen Rapp. 16 (Nijmegen 2010) (http://studiezaal.nijmegen.nl/ran/_detail.aspx?xmldescid=2001361671).