The KOR Seriation Program and its applicability in Archaeological Research

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Izvleček

Tu predstavljamo rezultate prvih poizkusov z razvrstilnim programom KOR. Ta je v obeh svojih različicah (KOR50, KOR62) računsko precej bolj zapleten od primerljivih programov, kljub temu pa še vedno zadovoljivo hiter. Poleg tega program dopušča vrsto nastavitev, s katerimi uporabnik lahko vpliva na način in intenzivnost računanja. Menimo, da je treba vsak tak program testirati na dejanskem arheološkem vzorcu. To smo tudi storili. Prvi rezultati, ki jih tu predstavljamo, okvirno kažejo na doseg takih metod razvrščanja.

Oba razvrstilna programa sestavljata skupine nosilcev z enakimi lastnostmi. KOR62 je pri tem hitrejši, skupine pa bolj vidne. Ponuja nam več "dobrih" možnosti, med katerimi si lahko izberemo najustreznejšo. Poleg tega lahko skupine razporedi v stratigrafsko zaporedje, če imamo na voljo gradivo z najdišča, kjer so taki odnosi bili. Program za iskanje skupin je tako samo orodje; od naše priprave vhodnega gradiva, od naše sposobnosti razlage dobljenega rezultata, od naših delovnih korakov je odvisen končni uspeh. Vendar ni izključeno, da bo s pridobivanjem izkušenj ob razvrščanju nadaljnjih najdišč zanesljivost programa bistveno narastla.

Abstract

Here the authors present the results of the first experiments with the KOR seriation program. This is, in both of its versions (KOR50, KOR62), relatively complicated in terms of computations, in comparison with comparable programs, in spite of which, however, it is still sufficiently fast. Apart from this, this program permits a range of modes, with which the user can influence the type and intensity of calculation. It is posited here that it is important to test each of these types of programs on an actual archaeological sample. This was also undertaken. The first results, which are presented here, approximately show the potential of such a seriation method.

Both of the seriation programs comprise groups of carriers with identical attributes. KOR62 is faster in this, whilst the groups are more obvious. It offers us more "good" options, from which the most suitable may be selected. Apart from this, the groups can be arranged in stratigraphic order, if material is available from a site where such relationship existed. The program for the definition of groups is, thus, only a tool, whose ultimate success is dependant on the preparation of the initial data set, our abilities to interpret the results achieved and our work steps.

However, it cannot denied that the reliability of the program will probably essentially grow with the gaining of experience through the seriation of further sites.

INTRODUCTION

Seriation methods are a very popular theme in the area of the use of computers in archaeology. It is not our purpose here to present the history and state of research, as up to 1988 alone over 117 bibliographic units had been published (Herzog, Scollar 1988, 53). For example Stadler (Stadler 1984) and Legoux and Périn (Legoux, Périn 1990) give concise histories.

The authors present here the results of the first experiments with the indigenous seriation program KOR. This is, in both of its variants (KOR50, KOR62), much more complicated than comparable foreign programs with regard to computation, although, in spite of this, in is still sufficienlty fast. Apart from this, the program permits a range of modes, with which the user can influence the type and intensity of calculation. It is posited that it is important to test each of these types of program on an actual archaeological sample. This was also undertaken. The first results, which are presented here, generally indicate the potential of such seriation methods, although it cannot be denied that the reliability of the program will essentially grow with the gaining of more experience in the seriation of further sites.

SOME PREVIOUS EXPERIENCE OF OTHER AUTHORS

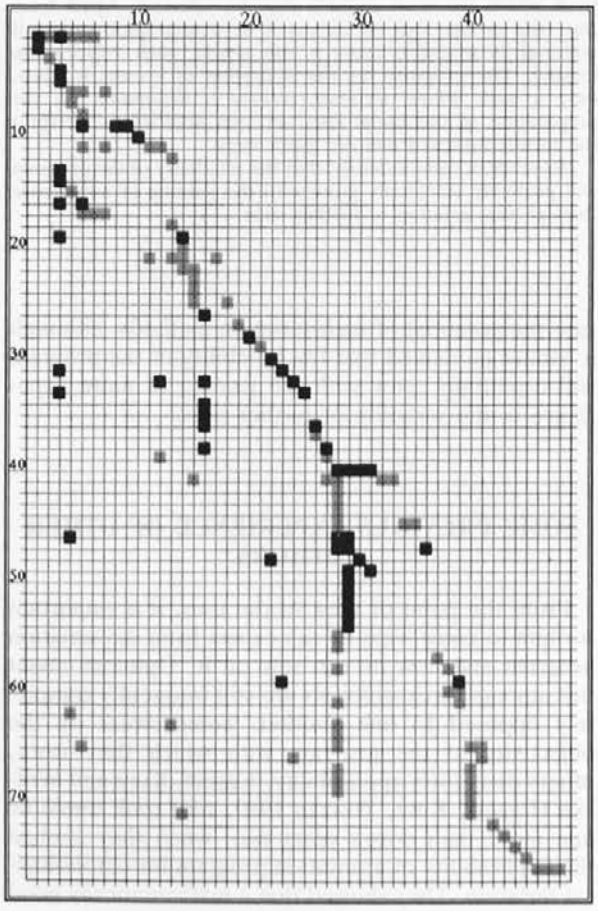
From the point of view of the user, it is important for him to know what he can expect from the seriation program and how he can rely on it. Opinions about this amongst archaeologists are still frequently completely opposed to one another. Some swear by the objectivity of the program with which they work, others deny their applicability. Eggert, Kurz and Wotzka (Eggert, Kurz, Wotzka 1980, 140) took a middle line more than dozen years ago, when they studied the applicability of a seriation program for chronological seriation. They showed that a mathematically good

result is not necessarily also historically useful. They warned of this that the program seriates the material by groups. These are usually correctly seriated in relation to each other with regard to the chronological order, which was sought, although the order within in the group is arbitrary, and different with each experiment. However, "jumpers" ("Springer") also exist, which connect first with one group and then with another. They appear for at least two reasons; either as attributes, which only occaisionally appear, or as carriers with only a few attributes. A certain blurring can be expected on the boundaries of groups due to the (in)stability of the seriation. The groups can be unclearly defined, particularly when the material only slightly changes over time (ibidem, 137 ss).

Certain dangers in seriation are known, which appear as a result of the attributes in the initial material. Too small a linkage of attributes can result in the inverting of the groups (Legoux, Périn 1990). However, in linkage, a chronological order from earliest to latest, or the opposite from latest to earliest, is equally possible. Further, it is advisable to analyse material from male and female graves separately, so that the groups will not combine by sex, or even by mixed chronological order (pers.comm. P. Stadler in: Daim, Lippert 1984, 69). Just as there exists an awareness that groups in the data can form for largely non-chronological reasons, e.g. groups of looted graves, technological and sociological differences etc. (Daim 1987, 41; Theune 1988, 12; similar: Beinhauer 1985, 155 ss).

The majority of authors try with the aid of seriation to locate chronological groups, whilst its use is also known with regard to specific artefact types (Legoux, Périn 1990) and with caution for the analysis of other site data, e.g. different forms of burial type (Daim 1987, 28). They normal analyse the cleaned data; they remove all of the attributes, which appear only once and all of the carriers with only one attribute and usually all of the attributes, which appear throughout the entire data set, so that it cannot disturb the final picture. Extremely severe cleaning can lead to this, that there is almost nothing left, which can be analysed (Daim 1987, 41).

Only rarely do the authors speak of the modes of group definition, of their boundaries. All define them with the aid of figures, which they recieve at the end of the computer or "hand" seriation. The boundaries of the groups ar defined by the places, where the groups of attributes begin or disappear (well presented in: Périn 1980, Fig. 73, 74). They still call for completely analysed material in the division into groups. Perhaps it is for this reason that it has already been "cleanded" and it is hoped that they have removed "jumpers"? Or on the basis of the logical assumption that it must belong somewhere? A clarification of this part of the process was not found in the papers by the authors.



Sl. 1. Sedlo na Blejskem Gradu. Spol nosilcev. Šifre nosilcev in lastnosti po zaporednih mestih uvrstitve.

Fig. 1: Sedlo on Bled Castle. Sex of the carriers. The numbers of the carriers and attributes are equal to the sequence of ranking.

1–01	13–13	25–25	37–37
2–02	14–14	26–26	38–38
3–03	15–15	27–27	39–39
4–04	16–16	28–28	40–40
5–05	17–17	29–29	41–41
6–06	18–18	30–30	42–42
7–07	19–19	31–31	43–43
8–08	20–20	32–32	44–44
9–09	21–21	33–33	45–45
10–10	22–22	34–34	46–46
11–11	23–23	35–35	47–47
12–12	24–24	36–36	48–48
1–088/089	20–028	39–137	58–005
2–136	21–056	40–077	59–074
3–023	22–053	41–085	60–012
4–011	23–054	42–144	61–041
5–163	24–048	43–072	62–159
6–043	25–004	44–032	63–060/019
7–101	26–067	45–166	64–007
8–022	27–170	46–065	65–009
9–146	28–040	47–164	66–024
10–058	29–096	48–076	67–147
11–090	30–055	49–093	68–036
12–020	31–031	50–149	69–082
13–062	32–015	51–152	70–006
14–010	33–027	52–059	71–044
15–087	34–094	53–155	72–154
16–013	35–049	54–165	73–002
17–091	36–102	55–033	74–081
18–037	37–086	56–003	75–029
19–025	38–097	57–168	76–143

DESCRIPTION OF THE FUNCTION OF THE PROGRAM

The purpose of every correlation program is to seek a logical sequence of attributes and their carriers. On a table with an organised sequence of attributes and their carriers on the axes, the appearence of attributes occurs in an organised manner. They combine in groups, which appear in chronological or other sequences. The size of the groups is usually varied. The interface between two sequential groups can be linked or stepped. Apart from this, attributes which appear unselectively in different groups, insert themselves between attributes, which only appear in specific groups of attributes. This means that a bell-shaped gauss-like distribution of the density of appearences within each group cannot be expected. A presumption about such distributions of the density of appearences is implicitly present in the majority of existing correlation programs. The presence of sudden cut-off points in the development of individual biological and cultural-sociological environments shows that such programs are not always ideal for the description of real samples.

Of course, the question of how to define the optimal order of the attributes and their carriers is decisive. In this article, the authors will describe two different approaches to this problem. In the first, "diagonal" approach (KOR50), the sample is organised, when the sum of the relative escaping distance between points, which mark the appearence of attributes in carriers, is minimal from the diagonal of the table. With this, it is permitted for individual attributes to have different weights, so that the diagonal position of the "weighted" attribute are more highly valued than that of the less important "light" attributes. The program also permits an additional option of allowing one to designate the "quarter" of the table, in which selected attributes should locate themselves.

Such a minimum distance from the diagonal cannot possibly be sought directly, as the list of N attributes can be put down to the N x (N-1) x...x 3x2x1 = N modes. It is necessary to help out with a statistical approach, by which an analogy from nature can be taken. If molten matter is cooled to a crystaline state, something similar happens: the chaotic distribution of atoms in the molten state gently transforms into the ordered network of the crystal. If different atoms are present in the molten state, some of which are heavier than others, then these will stabilize and "freeze" in their place in the growing crystal before the others. It is also possible to talk of the "temperature" of the sample in the correlation program. At the start of the ordering process, the temperature of the sample is high. The sample is chaotic, whilst the high temperature permits optional exchange in the order of the attributes and their carriers. "Cooling" follows, which is undertaken in sequential steps. Each step is 10% lower in temperature than the preceeding step. The program carries out the following operations within the parameters of a step:

a) it selects two attributes and two carriers by accident,

b) calculates the running distance of the full points in these two attributes and carriers from the diagonal,

c) temporarily exchanges these two attributes and carriers with each other,

d) calculates new running distances, as under (b),

e) calculates the value of the exponent function, which has the difference between the old and new distances, divided by the momentary temperature, as an argument,

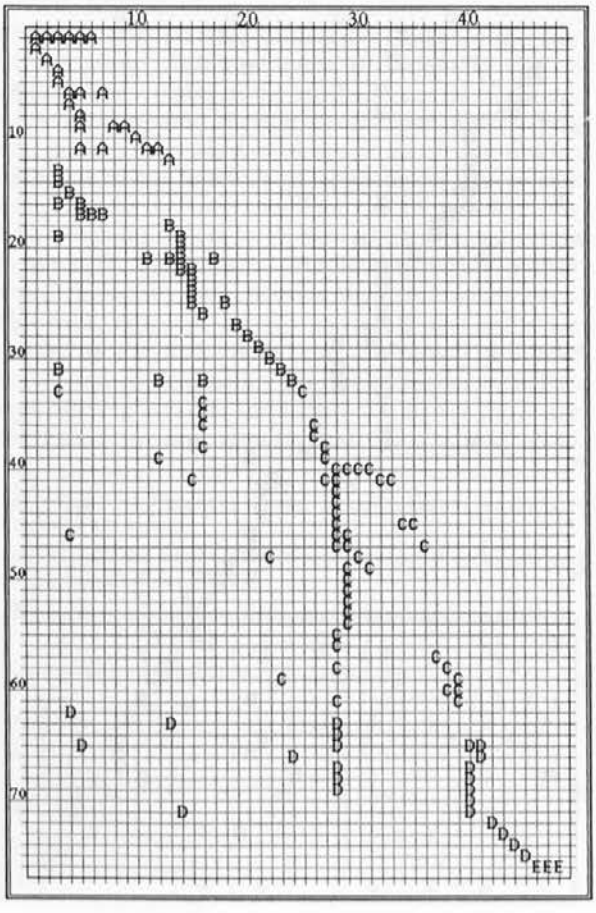
f) if the value of the exponent function is less than that of the initially selected number at an interval of between 0 and 1, it carries out the actual exchange, otherwise it retains the old order,

g) M – times repeats operations (a) to (f),

h) if none of the M exchanges were successful, it concludes that the sample has frozen and ends the organisation process; however, it usually lowers the temperature for 10% and repeats operations (a) to (g) in the framework of the next temperature step.

The scheme, described, has some important advantages. In the first phase of calculation, practically all attempts at exchange are successful, so that it quickly negates the influence of the ranking of the data on entry. Gradual cooling also usually permits some exchanges, which are disadvantageous to the momentary ranking of the sample, although it does prevent the ordering from ending at one of the localised maximums

Sl. 2. Sedlo na Blejskem Gradu. Pripadnost pokolenjem.
Fig. 2: Sedlo on Bled Castle. Generational membership.

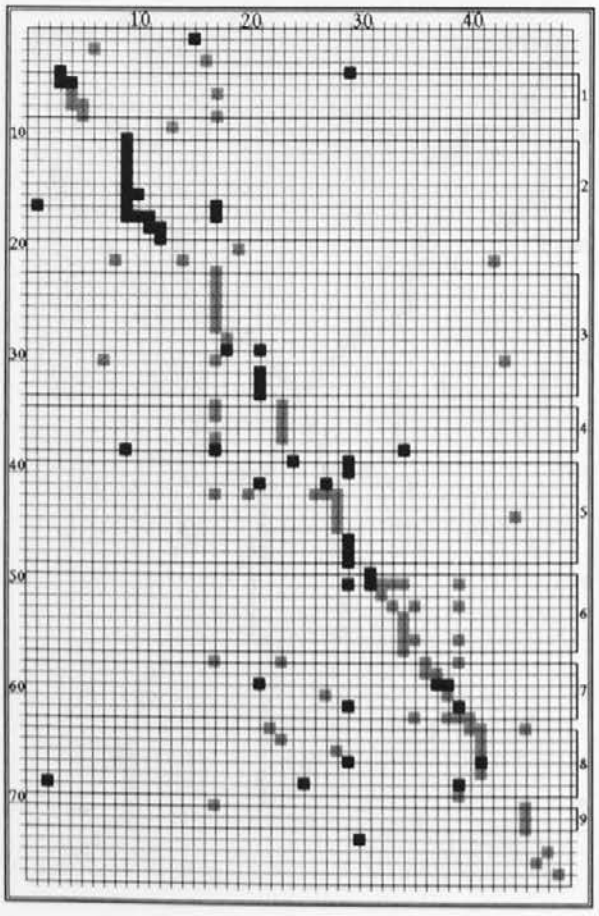


of ordering and thus missing the globally most advantageous solution.

It is also necessary to mention two disadvantages, as well as the advantages. The first is the calculation time. If N is the number of attributes or their carriers, then the calculation time increases at approximately with the fourth potential of N. In practice, this means that it is not possible to organise a table with more than a few hundred members on a microVax computer. We later further improved the program. The candidates for exchange (step a) were no longer selected exclusively, but precedence was given to those, which "sat" in their place in the table at a given temperature. The temperature steps were also different, the difference between the sequential temperatures was smaller during the stabilization of the sample in the ordering of the structure. The calculation was increased by about 10 times as a result of these changes. MicroVax can now deal with a sample with 400 attributes and as many carriers in a few hours of CPU time.

The other disadvantage is more in the nature of a principle. The idea that the points of the ordering of the sample should collect along a diagonal, is otherwise aesthetically and mathematically attractive, but frequently does not happen in reality. As the size of the sequential groups differ from one another, the spine of the ranked sample runs between the two opposite poles of the table in the form of an arc or, better still, in the form of a twisted curve and not by nature in a diagonal. Of course, the forms that this spine will take are not known beforehand, so that it pays to experiment with a alternative method to seriation.

This alternative method (the KOR62 program) is also described as "ranked". The table is constructed here in a single operation, as opposed to that of KOR50. Firstly, the initial carrier is selected. The carrier, whose attributes best fit those of the first carrier, is placed in the second position. The third, which follows, is that, which has the best correlation with the first two, and so on, until all of the carriers are ranked. The carrier, which best correlates with the already ranked attributes, is that, which has the most dynamic weight. This is defined as the sum of the weights of those attributes, which are present in the carrier and have already been ranked. Recently ranked attributes count for more than less recently ranked attributes. That which is counted as a recently ordered attribute is indicated by the expected size of the group, the parameter, which must be set before the start of calculation. Finally, the sum of the already ordered attributes is decreased by a proportion of the attributes, present in the carrier, which have still not been ranked in the table. The program also permits the option of defining in the initial data, which of the carriers it should rank before and those, which it should rank after. It is possible, for example, to achieve the ranking of earlier graves before those of a later period with this specification of before: after pairs.



Sl. 3. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 3: Sedlo on Bled Castle. Groups and sex of carriers. The number of the carriers and attributes are equal to the sequence of seriation.

1–36	13–42	25–08	37–24
2–09	14–46	26–32	38–12
3–23	15–10	27–27	39–05
4–39	16–44	28–15	40–11
5–38	17–28	29–03	41–14
6–45	18–26	30–20	42–47
7–34	19–43	31–01	43–35
8–48	20–33	32–02	44–18
9–29	21–16	33–06	45–13
10–31	22–17	34–04	46–37
11–30	23–40	35–07	47–21
12–22	24–25	36–41	48–19
1–058	20–002	39–027	58–024
2–029	21–143	40–010	59–015
3–081	22–144	41–097	60–137
4–031	23–012	42–085	61–013
5–168	24–041	43–048	62–090
6–007	25–032	44–004	63–056
7–060/019	26–072	45–054	64–044
8–003	27–159	46–062	65–053
9–154	28–086	47–011	66–025
10–152	29–102	48–163	67–028
11–165	30–166	49–136	68–146
12–155	31–094	50–088/089	69–022
13–059	32–067	51–023	70–074
14–149	33–049	52–091	71–037
15–093	34–082	53–005	72–020
16–164	35–036	54–087	73–040
17–077	36–006	55–043	74–096
18–076	37–147	56–101	75–033
19–055	38–065	57–009	76–170

The advantage of this method is twofold. The ranking of a specific carrier is influenced only by its connections with already ranked carriers. This is more logical than the "diagonal" criteria (the KOR50 program), which is suitable for the ideal ordering of a sample, similar to a correct crystal, which actual archaeological samples do not resemble. Apart from this, the demands of calculation are essentially less and the speed of calculation is much greater than that in the KOR50 program. Calculation can be repeated with different initial carriers and the results can be compared with each other. The program can also independantly estimate, which of the results are more logical. In a moment, it chooses that, which has the greatest sum of dynamic weights of its individual carriers by their ranking in the table. This criteria is logical, although possibly not optimal. The authors also intend in the near future to experiment with other options for the selection of an optimal seriation result. It is hoped that this will increase the quality of the results achieved.

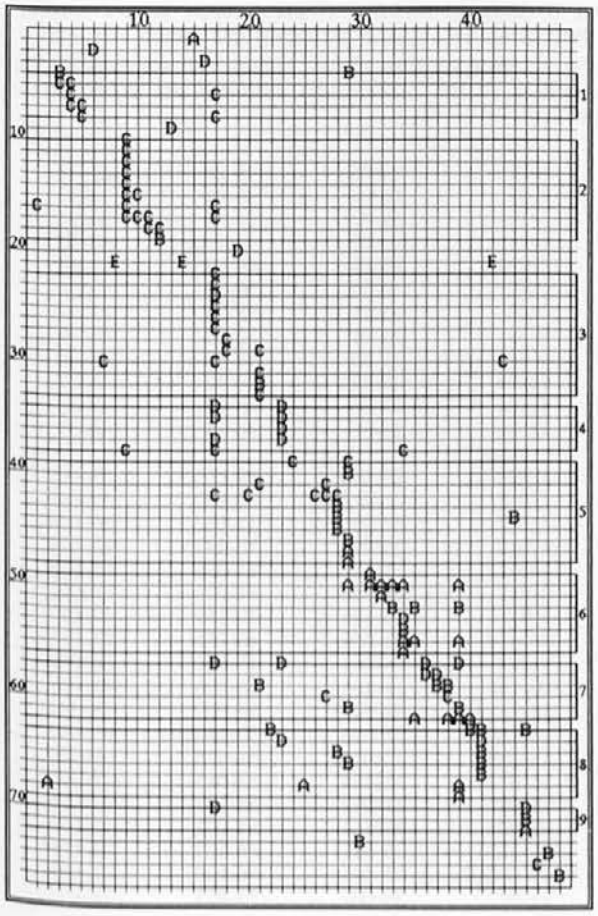
ENTRY DESIGNATIONS, ENTRY AND EXIT DATA BASES

The entry data base for KOR50 is composed of three parts. The first is the list of carriers with the attributes, which they contain. The second is the list of attributes with their weights from 1 to 100 (whole numbers), which the user designates himself. It is also possible here to denote the quarter of the table, in which a specific attribute will seriate. The third section is the list of values of individual distances from the axes. These must be whole, positive numbers. The best result gives a linear fall in value of one. The number of values must be at least as great as is the greatest of the entry data of the most numerous type (carriers or attributes). With KOR62, this third section is exchanged with a list of carriers, which have before: after relationships. The intention here is to include data about the layering of site structures.

Both forms of the program permit the user to set some of the entry designations for computation. With KOR50, the intensity of mixing can be defined, which means how many movements of a defined attribute in the average the program tests at each value of temperature. A one times greater intensity also means an equally lenght of calculation time, although this must not be too small, as the sample will naturally cool too quickly. Further, it is possible to designate how great the distance should be for the testing exchange of chosen carriers spread out around the average value. The best are values between 2.0 and half of the value of the intensity of mixing. We have two options to decrease the calculation time. We can begin with a lower starting temperature or we can increase the speed of cooling. However, each of these types of acceleration gives an inferior result.

With KOR62, the entry designations are naturally different. It is possible to define a scale for the size of the group. Different types of weighting can be chosen. The weights of the attributes can be the same, without taking into account the number of appearences, equal to the number of appearences, the reverse of equal to the number of appearences, or as one designates in the entry data base. At the moment, the best weighting seems to be that which is equal to the number of appearences. Attributes, which appear more frequently, are heavier than infrequent ones. However, different weights above all have influence on the choice of the initial carrier. Namely, we have the option of designating the initial carrier ourselves and carrying out one seriation only, or we can leave the choice to the computer and tell it to test all of

Sl. 4. Sedlo na Blejskem Gradu. Skupine in pripadnost poko-
Fig. 4: Sedlo on Bled Castle. Groups and membership of generations.



Sl. 5. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 5: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A					♂	♂	♀	♂	♀
B	♂	♂	♂		♂	♀	♂	♂	♀
C	♂	♂	♂	♂	♂		♀		
D			♀	♀		♀	♀	♀	♀

the carriers, which have weights above the given % of weight of the heaviest carrier, as initial carriers. The experimental sample gave the best results at a value of circa 50 %. The last option is that the program also takes the before: after relationship into account, if we so desiere.

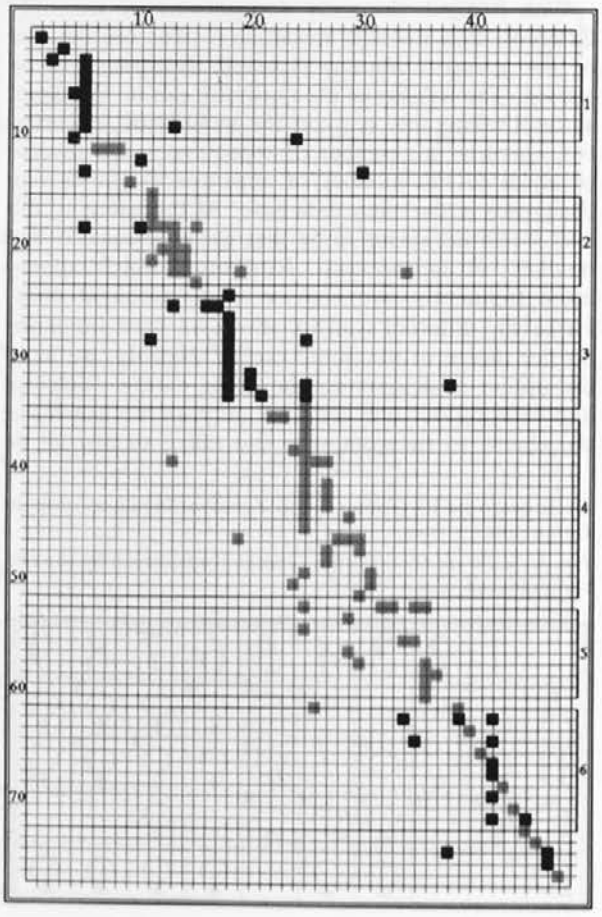
The KOR50 program has two exit data bases: *.par and *. rez. The first comprises the coordinates of the points, which denote the presence of attributes in carriers, the second comprises a list of attributes, their ranking in the table, the ranking positions of the last 22 temperature steps, the average ranking position of these steps and the average divergence from this position. Several *.par and *.rez data bases are formed in each seriation, which make possible the observation of the formation of groups. Things are different with the KOR62 program. This has three exit data bases: *.la, *.no and *.par. The latter is the same as in the previous program. Data base *.la contains attributes their ranked positions and number of appearences. Data base *.no contains carriers and their ranked positions, number of attributes contained, combined weight of attributes, the dynamic weight at the moment of ordering, the number of new attributes, which the carrier brought with it at the moment ordering and the designation of its possible inclusion in terms of "before: after."

Both programs also allow the acceptance of the course of seriation, which is preserved in a special data base, if one works in batch mode. Thus, one can quickly identify the most promising initial carrier with KOR62.

GAINING PERSONAL EXPERIENCE

In order to determine comparability with existing seriation programs, the beads from the Alamannic cemetery of Weingarten were analysed anew with our program. These have already analysed with the P. Ihm's program (Theune-Vogt 1990, 4) on which Herzog and Scollar also based in their development of the BAS package (Herzog, Scollar 1987, 274), which is probably the most widespread amongst archaeologists at the moment. The figure, which was created with KOR50, was very similar to that, which was published by C. Theune-Vogt (ibidem, Abb. 1). Our proccedure was carried out so that the attributes were unweighted. Such a similarity means that the two programs and their results are comparable.

Another test of our program was the Bavarian cemetery at Altenerding, the seriation of the beads and belt buckles from the site. In the course of time, it showed a necessity after the analysis of material, where the result should already be known, that the effect of the program should be better displayed. We examined an artificial sample, which attempted to simulate a real archaeological sample in a simplified



Sl. 6. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 6: Sedlo on Bled Castle. Groups and sex carriers. The numbers of the carriers and attributes are equal to the sequence of seriation.

1–20	13–05	25–28	37–18
2–25	14–07	26–41	38–30
3–10	15–02	27–40	39–24
4–23	16–09	28–17	40–43
5–03	17–08	29–13	41–44
6–47	18–29	30–14	42–16
7–46	19–11	31–38	43–42
8–48	20–31	32–32	44–19
9–45	21–36	33–33	45–26
10–01	22–34	34–12	46–21
11–04	23–35	35–27	47–22
12–06	24–39	36–15	48–37
1–040	20–091	39–009	58–004
2–058	21–043	40–032	59–048
3–027	22–090	41–082	60–054
4–010	23–023	42–147	61–024
5–062	24–152	43–036	62–015
6–031	25–146	44–074	63–002
7–011	26–155	45–159	64–097
8–163	27–059	46–056	65–081
9–013	28–065	47–044	66–049
10–168	29–165	48–006	67–067
11–143	30–149	49–003	68–154
12–136	31–093	50–060/019	69–094
13–025	32–077	51–028	70–170
14–029	33–164	52–085	71–102
15–087	34–072	53–037	72–086
16–005	35–166	54–041	73–096
17–101	36–012	55–137	74–076
18–088/089	37–144	56–020	75–055
19–022	38–007	57–053	76–033

way, but this showed that it is not possible to completely substitute for the real material. Thus, we chose the Old Slavic cemetery Sedlo na Blejskem gradu as an experimental example.

THE DEFINITION OF GROUPS

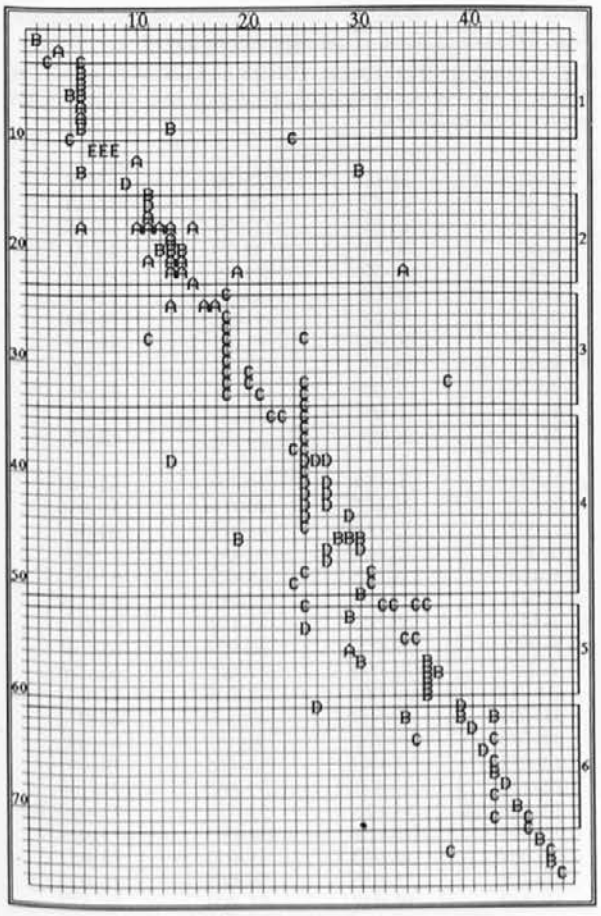
Firstly, let us see how is with KOR50. The usual method of group definition with the aid of combination tables has already been mentioned. However, this method has other inadequacies apart from those of its content. The large number of attributes, which are present everywhere, naturally somewhat cloud the picture. However, if we opt for "cleaning", we can, of course, remove them and obtain a better picture. It is more difficult, when we decide that we will begin to weight the attributes, as we are of the opinion that some of them are more important than others for our seriation. Thus, in the final figure, these attributes cluster closely along the diagonal, whilst the remainder are dispersed around. The existing standard for group definition failed here.

The solution is derived from the way in which program works. At first, they sit on the carriers with the heaviest attributes and, thus, initiate the crystallization of the core of groups, around which the lighter carriers gather. As we have *. rez data about position in the exit data base, where the program located the carriers in the final temperature steps, we can help ourselves with this. We note in which places the carriers "oscillated". The weighted examples strongly hold their position, whilst the light ones shift up and down, but only within defined parameters. Positions exist, which the carriers do not reach, neither those from the upper group, nor those from the lower group. These places are the boundaries of the groups. A group is composed in such a way that weighted carriers form its core, whilst lighter carriers form its boundaries, as they least disturb this program there. The lightest carriers, which have no good connections with the others, are placed by the program at the beginning or end of the diagonal. Something similar happens to the attributes, which appear throughout the entire sample. The program places these at the beginning, end or in the middle, where they least disturb it. However, on the figure itself, we note that the boundaries of the group, which we defined with the review of the oscillation area of the carriers, correctly fit with the horizontal discontinuities which appear on the table. These are caused by the light carriers – "garbage" – which the program compresses between the groups, as they least disturb it there. Thus, the "garbage" with their easily visible discontinuities help to define the groups.

The determination of the groups in KOR62 is more simple. The program actually seeks carriers, which by their attributes, are most similar. In the exit data base *. no, we have the data on this, of how many new attributes, the ranking of an individual carriers has brought and the degree of its fit with the previous carriers, expressed with a dynamic weight. The entry of new attributes, along with the lessening of the fit, is the sign of a new group. Certainly, we can ask how many new attributes make a new group. The answer is difficult enough, so as not to simplify matters: one alone is enough, if it is that, which we decide is important. The program adds the light carriers to the heavier ones, if they fit with them through their attributes. Thus, the larger groups are well marked on the table. The remaining "garbage", which have no links at all, are placed at the end by the program. It can be said that it puts them in a heap. Thus, the garbage is also useful in this program: they emphasise

Sl. 7. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 7: Sedlo on Bled Castle. Groups and membership of generations.



Sl. 8. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 8: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂	♂♀	♂		♀				
B	♂	♀		♀	♀	♂♀			
C	♂		♂	♀	♀	♂♀			
D		♀		♀	♀	♀			

certain groups, the nonuseable are easily seen at the end. – Steps form on the table as a result of the entry of new attributes, which define the boundaries of groups.

However, it is valid for the explanation of the tables of both programs that we must not forcibly compress all of the carriers, as we will also certainly gather all of the garbage.

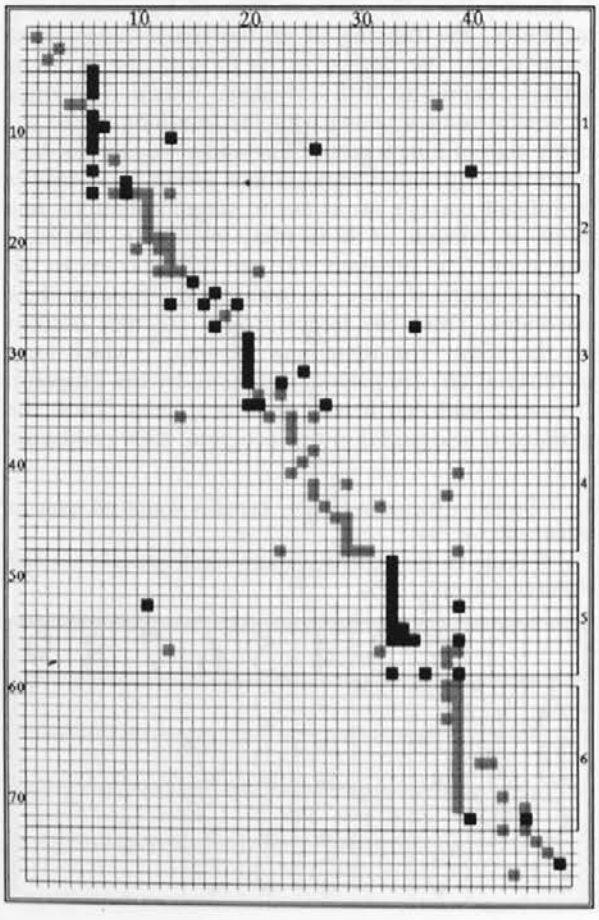
ON THE PRESENTATION OF THE SAMPLE

Accumulation in vertical layers is characteristic for the graves from Sedlo, at the same time, along with the ambition of each generation, that the burials would even so be in rows. On this basis and on taking into account the types of the artefacts in the graves, it was possible to divide the cemetery into four generations and at the end present them in a table (Pleterski 1982, fig. 5). This was taken as the initial comparison, as it reflected the actual distribution of the material over time, because the chronological groups were defined from the layers and not on typological-combination groups.

In comparison with the original table, we added to the third generation carriers 012, 159, 060/019 and 007, which improve the relationship between male and female, although not in opposition to the basic criteria of the ordering. Carrier 143, which of course might belong to the period of the fourth generation, was seperately marked (E), because of a Bijelobrdo earring, which indicates a new generation, which was no longer buried in this cemetery.

As the detailed physical anthropological analysis of the skeletal materials is not yet complete, the sex of the deceased was defined on the basis of characteristic grave goods: a knife, deer antler tine, a metal ringlet at the belt and pig bones are found in male graves. Such a division does not contradict the anthropological data from neighbouring contemporary cemeteries. Of course, in spite of this, it is not inevitable that such a picture, obtained, should completely reflect reality, although it is firm enough for recognition of the results.

We deliberately retained from dividing the male and female graves in the material from Sedlo. We expected that the program would seriate the material into groups of male and female graves and their relative ranking interested us. Namely it should be noted that different groups can also form within the framework of graves of the same sex, which may or may not be chronologically related. Will we know how to understand them? Male and female are for us only a symbol of the less understandable causes of group formation – for this reason, we also retained all of the "garbage" – attributes in the material, which appear only once, and carriers with only one attribute. We should not, namely, think that with this scale that we could remove everything, which the program could consider



Sl. 9. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 9: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the carriers and attributes are equal to the sequence of seriation.

1–42	13–05	25–26	37–48
2–43	14–11	26–14	38–40
3–37	15–20	27–24	39–28
4–47	16–09	28–18	40–23
5–46	17–22	29–15	41–35
6–03	18–21	30–33	42–34
7–25	19–08	31–32	43–38
8–02	20–16	32–41	44–19
9–01	21–12	33–29	45–39
10–06	22–17	34–31	46–45
11–04	23–27	35–30	47–44
12–07	24–13	36–36	48–10
1–154	20–091	39–086	58–164
2–033	21–022	40–074	59–036
3–002	22–090	41–053	60–147
4–010	23–040	42–044	61–032
5–163	24–055	43–024	62–082
6–011	25–146	44–004	63–159
7–143	26–096	45–048	64–012
8–062	27–076	46–054	65–144
9–027	28–094	47–085	66–166
10–013	29–067	48–059	67–041
11–025	30–049	49–149	68–072
12–023	31–102	50–152	69–003
13–031	32–097	51–165	70–007
14–136	33–137	52–065	71–168
15–088/089	34–015	53–155	72–060/019
16–005	35–056	54–093	73–029
17–087	36–037	55–077	74–081
18–101	37–020	56–009	75–058
19–043	38–028	57–006	76–170

as "garbage." As we did not remove the clearly visible garbage, it was possible to note what the program did with them and so anticipate what and where are hidden "garbage."

ON THE FIGURES IN GENERAL

All of the figures, which are presented here, concern seriated material from the cemetery at Sedlo. We took the number of graves, which represent the carriers here, and gave the numbers 01 to 48 to the artefacts from the graves which here represent the attributes (*pl. 1*). The individual experiments are presented in three ways.

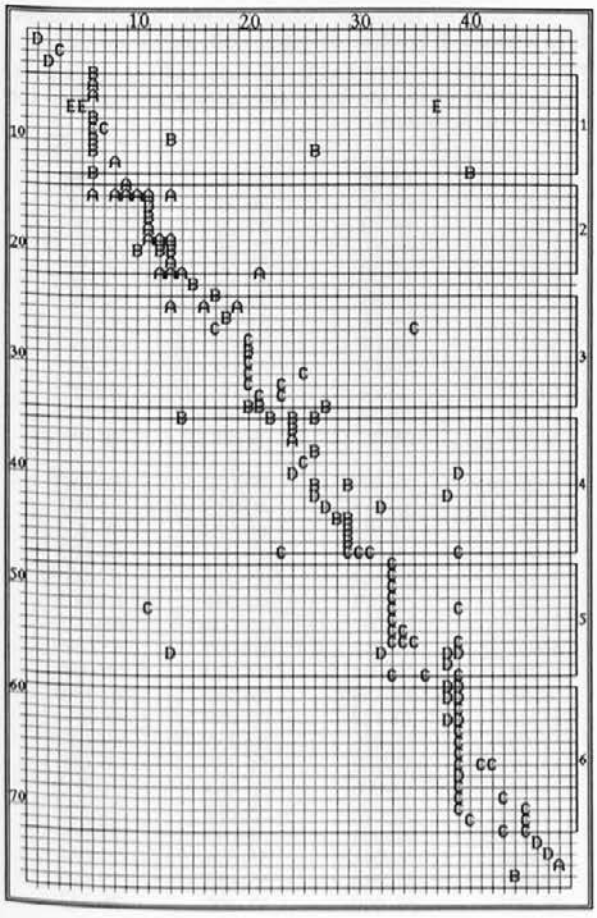
The first is the table, where each square represents an attribute (= artefact) of an individual carrier (= grave). The black coloured examples represents male graves, whilst the gray ones are the remainder, correctly female, examples. Carrier 088/089 is treated as a pair of man and wife. The horizontal numbered apex of the table shows the sequential positions of the attributes, whilst the vertical represents the sequential positioning of the carriers. The position, in which the individual attribute or carrier is located, can be determined from the adjacent numbered columns, which firstly indicate the seriation of the attributes and secondly that of the carriers.

The following table is basically the same, only that letters are substituted in the place of the squares: A, B, C, D, E. Each represents the generation to which the individual carrier belongs.

The third table has numbered groups of carriers, which could be defined with the aid of seriation, whilst letters denote the generations, in which these groups appear. The symbols for male and female indicate the membership of individual groups of carriers to a specific sex in an individual generation.

Sl. 10. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 10: Sedlo on Bled Castle. Groups and membership of generations.



EXAMPLES

The material from Sedlo is small enough to be taken in, whilst simultaneously it already shows all of the features, which are much more marked in larger samples. *Fig. 1* is the initial comparative state, the somewhat graphically designed table from 1982. *Fig. 2* shows the generations to which the carriers belong. The figures express the actual state; those which may be designated as groups, are relatively unorganised, some of the attributes are independant of their frequency distributed over very long time. Different groups appear at least partially contemporaneously, in generation D there are no more male graves with grave goods, most probably due to the abandonment of traditional burial rites.

The following three groups of figures show the seriation carried out, with the "diagonal" KOR50 program. All of the entry designations were in every case indentical, so that the influence of these, which we cite separately in each example, would be more obvious. *Fig. 3* was formed under the influence of the following entry designations: the attributes were weighted in context with a judgement of their greatest or least chronological sensitivity, the area (quarter) of ordering was not defined for them. – A clear diagonal line can be seen, which is formed by the heavy attributes, the light ones are much more evenly distributed. The number of groups is relatively large and the sexual distribution is not very well marked. The garbage is located at the beginning and the end, as well as partially in between the individual groups. *Fig. 4* shows quite a disorganised distribution from a chronological point of view. It is characteristic that the garbage also chronologically stands out from the chro-

Sl. 11. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

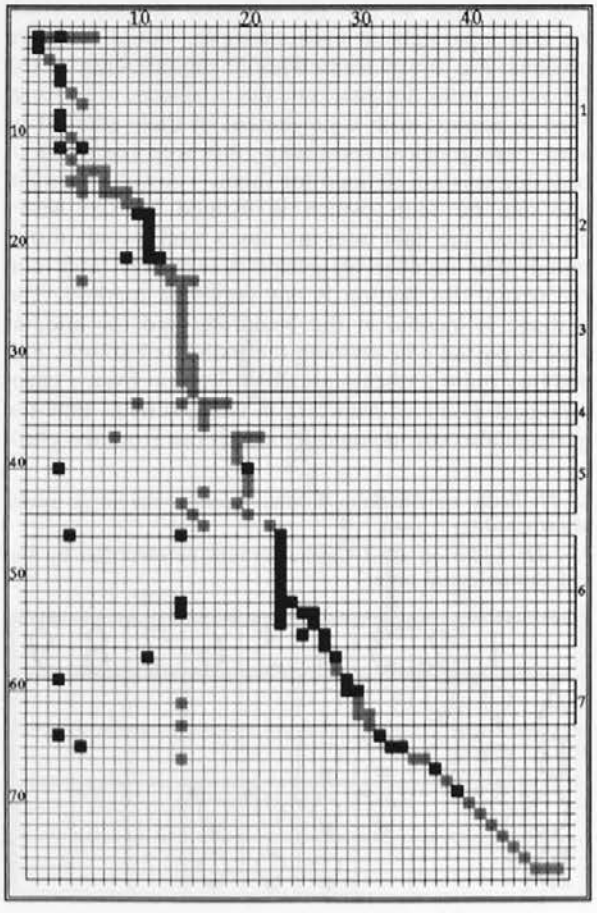
Fig. 11: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂♀	♂♀	♂	♀					
B	♂	♀	♂♀	♀					
C	♂		♂♀	♀	♂	♂♀			
D				♀	♀	♀			

nologically secure members of the groups, on which they border. The ordering of grave 143 (generation E) at the 21st position between groups 2 and 3 is important. It appears there as garbage, which has no connections with the remainder of the material. Also, if this were a group, something similar would probably happen. In work with an artificial sample, it was very clearly indicated that the same groups allways remain with the same contents, whilst their relative order, if they have to few links between them, is different in virtually every experiment. Thus, the argumentation of the chronological order in such groups is more than risky. *Fig. 5* shows that no single group belongs to a single generation, but to a least two, or even four. It is even more important that the groups appear very extended over time (e.g. groups 6, 8, 9). Two groups belong to one sex alone (2, 9), whilst an interesting feature is shown in the remainder. Male carriers appear in them before female ones, which might mean that the temporal linkage of male graves does not fit with the female graves. Or expressed differently, that it is necessary to seriously discuss the possibility that the same attributes do not always appear contemporaneously in male and in female graves, but that it is skewed.

The entry designations, which affect *fig. 6* were the same as those in the previous experiments, with the exception that the attributes were unweighted. The central location of the attributes on the diagonal is now essentially greater than before, the groups are fewer than before, but are more condensed and visibly divided by sex. The garbage here is located at the beginning and end, as well as partially between the groups. However, as *fig. 7* shows, the groups are chronologically strongly mixed, garbage – carrier 143 is squeezed into the 11th position between groups 1 and 2. The groups are strongly distended over time (*fig. 8*), partially even disrupted (2, 3). They belong to only one sex, apart from two groups (2, 6), where the male carriers only appear in the initial generations and then no more.

The last experiment with the "diagonal" program (*fig. 9*) also had unweighted attributes in the entry designations, although we designated a quarter of the table, where certain of the attributes should order: attributes 01 – 06 in the first quarter, 40, 41, 48 in the last quarter. As a result of general experience, we presupposed that the former were earlier and the latter were later. The number of the groups was the same as before and generally also had the same contents. The same is evident in the formation of the groups by sex. There is also same garbage here at the beginning and end and partially between the groups. It is interesting that carrier 143 inserted itself into the first group with attributes without a defined quarter, whilst the defined attributes float far from the diagonal, that could stand at the beginning of the last quarter. The conditions for the last quarter were



Sl. 12. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 12: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–01	13–41	25–30	37–10
2–02	14–28	26–31	38–19
3–03	15–40	27–22	39–20
4–04	16–15	28–26	40–21
5–05	17–32	29–23	41–37
6–06	18–33	30–39	42–42
7–07	19–13	31–38	43–43
8–11	20–14	32–25	44–44
9–12	21–17	33–08	45–45
10–27	22–18	34–09	46–46
11–16	23–29	35–34	47–47
12–24	24–36	36–35	48–48
1–088/089	20–049	39–037	58–086
2–136	21–015	40–025	59–031
3–023	22–024	41–028	60–168
4–011	23–009	42–053	61–007
5–163	24–144	43–074	62–060/019
6–101	25–072	44–044	63–003
7–022	26–032	45–004	64–027
8–062	27–012	46–065	65–146
9–010	28–041	47–149	66–166
10–087	29–159	48–152	67–058
11–013	30–147	49–059	68–170
12–005	31–036	50–155	69–040
13–091	32–082	51–165	70–096
14–043	33–006	52–164	71–033
15–090	34–085	53–077	72–154
16–137	35–054	54–093	73–002
17–097	36–048	55–076	74–081
18–067	37–056	56–055	75–029
19–094	38–020	57–102	76–143

evidently too weak, that the carrier itself might also go to the bottom of the table. The first evident difference from the last table (*fig. 6*) is this that the long columns of attributes do not appear only at the ends and above in the centre, but also are better distributed. However *fig. 10* shows the general rule of movement from earlier to later groups. This is well represented in *fig. 11*. First, the three earlier groups are ranked, the fourth covers the whole time period and then the two later groups. The sexual division is slightly less marked. However, the male carriers still largely appear before the female ones in the mixed groups. Naturally, the groups cross several generations, but are not disrupted.

The remaining examples were created with the KOR62 program for "ranked" seriation. *Fig. 12* shows the table, which was created from the following entry designations: the temporally more sensitive attributes were more weighted, the size of the group of attributes is 12 and for the start a pair of graves 088/089 was defined. Seven groups can be seen, which are well divided by sex, the first is markedly mixed, as it is the introductory pair of male and female carriers. The garbage is seriated partly between the groups, but largely at the end. As the introductory carrier is from the earliest generation (*fig. 13*), the introductory group is mainly earlier, only carrier 005 in the 12th position belongs to generation D. There follows a rapid entry into the later groups, which are chronologically mixed. This is shown by *fig. 14*, where it is clear that groups 1 and 5 are chronologically disrupted. Groups 3, 4 and 6 belong to only one sex, whilst male and female carriers appear to be temporally skewed in the others, e.g. group 2.

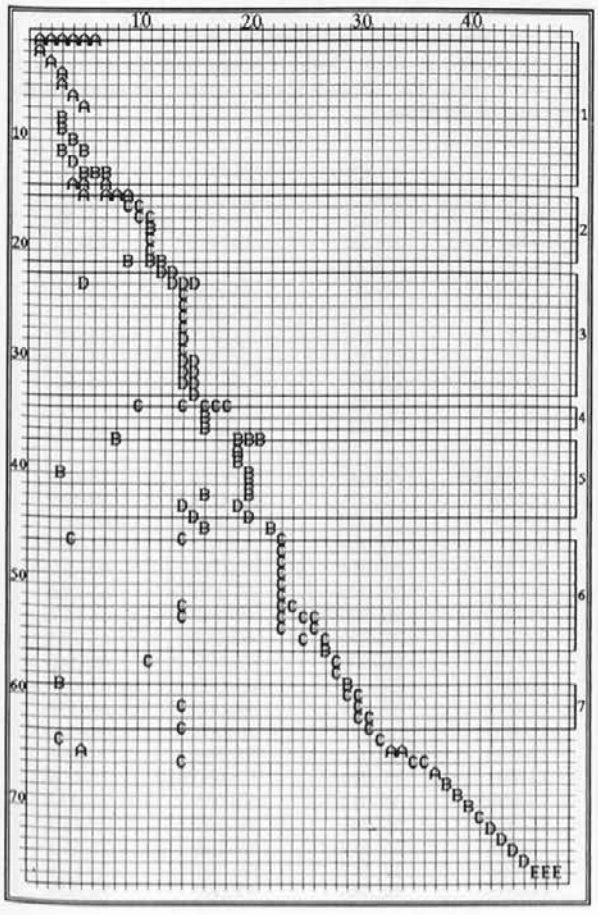
With the experiment on *fig. 15*, the entry designations were the same as before only the weight of all of the attributes was relative to the number of appearences. The contents of the groups remained generally the same, only their internal distribution is different. The garbage is partly between the groups, but largely at the end. The general chronological distribution (*fig. 16*) runs from older to later groups. Groups 3 – 5 belong to a single sex (*fig. 17*), whilst 3, 5, 6 are for the first time of only one generation. There is also a temporal disharmony between male and female carriers here within the same group (e.g. group 7).

An experiment with attributes of the same weight (*fig. 18*) perhaps gave slightly more pleasing groups, which are still divided by sex, whilst they are chronologically (*fig. 19*) more mixed than before, which is shown by *fig. 20*. Only group 4 belongs to one generation alone.

In the last three experiments, the option of an entry designation was not used, which allows the before: after relationship between the carriers. However, in the following (*fig. 21*) that option was also included, the size of the group of attributes was 7 and the attributes were weighted in relation to the number of appearences. The groups are a little less evident, extremely divided by sex and the garbage was partly located between them, but largely at the end. They were chronologically distributed from earliest to latest with clouding at the end (*fig. 22*), which is also shown in *fig. 23*. Groups 3 – 6 belong to carrier of only one sex, groups 4 and 5 to those of only one generation. For the first time, a group formed, which belonged only to generation D – group 5. The before: after relationship, which expresses the stratigraphic position so strongly influenced the correct order and even marked the individuality of generation D, which had always been previously mixed with the other groups. As the before: after relationship was too small, part of the material remained outside of it, which is seen

Sl. 13. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 13: Sedlo on Bled Castle. Groups and membership of generations.



Sl. 14. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 14: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂♀	♀			♀				
B	♂♀	♂		♀	♂♀	♂	♂		
C		♂♀	♀	♀		♂	♂♀		
D	♀		♀		♀				

as garbage between groups 5 and 6 and the group of male graves 6, for which these relationships had not been included.

The double-edged nature of the before: after option is even better shown in *fig. 24*. The single initial change from the previous experiment is that a different carrier was chosen for the start, in this case, 065 from generation C. Only the first group is strong, the others are strongly fragmented, but still largely ordered by sex. There is a lot of garbage amongst them, the rest is at the end. Chronologicaly, the groups are slightly mixed (*fig. 25*). The beginning is later, with a convulsive entry to the earlier groups and after that a more correct continuation to the later ones (*fig. 26*). Only group 4 belongs to a single generation.

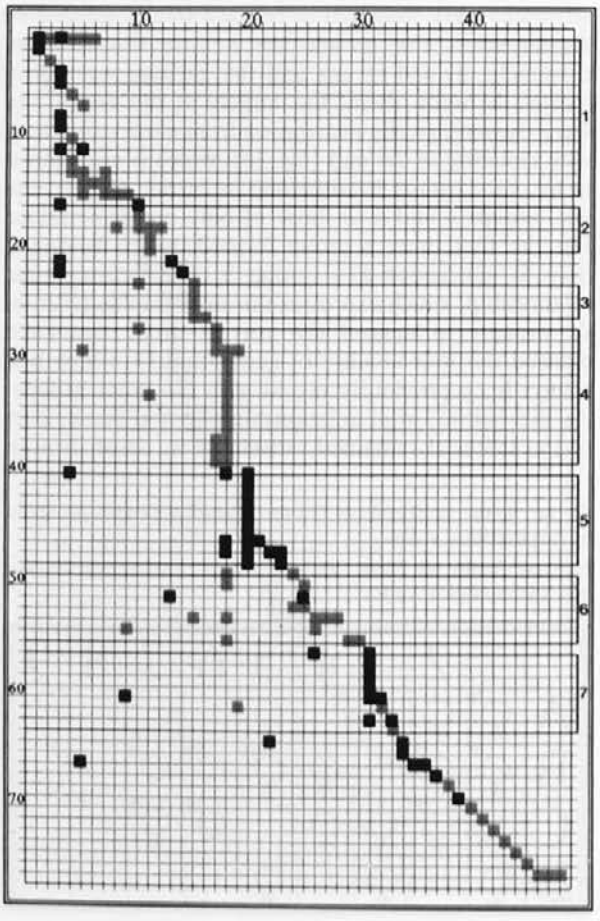
The next experiment (*fig. 27*) has the same entry designations as the last, only that it does not use the before: after option, but begins with the heaviest carrier, 009 from generation D. There are essentially fewer groups, they are clear and markedly divided by sex. However, the chronological order (*fig. 28*) is strongly mixed. All include several generations (*fig. 29*). Three groups are female only, the remainder are mixed, male and female carriers appear in them in chronological alignment.

As there are as many possible beginnings to seriation as there are carriers, it is useful to employ an option, which is offered by the program. This, taking into account the specific weight to the carriers, tries one against another and suggests the mathematically best option. This is shown in *fig. 30*. The pair of carriers 088 and 089 were placed at the beginning, whilst the scale for the size of the group was lowered to 5. The remaining entry designations were the same as before. Division by sex is now extremely marked. Carriers, which do not form larger groups were judgementally excluded. The chronological order (*fig. 31*) shows that the beginning is in the 3rd generation, generation C. The groups somewhat oscillate over time (*fig. 32*).

However, amongst the best beginnings was that, for which it was not possible to say that it better conformed to our wishes (*fig. 33*). As regards content, the groups are of course similar to those from the last experiment. The ordering by sex is similarly relatively marked. However, it has a more correct chronological order for the groups (*fig. 34*), which runs from earlier to later. However, the last two groups here are not formed to a large extent from the last generation (*fig. 35*). In fact, the two groups (4, 5) belong to one generation and are of only one sex, which is a result of more exacting rules for the definition of groups. It is interesting that an independant group from the latest generation D also formed in this experiment.

CONCLUSIONS

The groups at least partially overlap, so that the boundaries between them cannot be equated with



Sl. 15. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 15: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–01	13–23	25–39	37–10
2–02	14–25	26–27	38–19
3–03	15–15	27–32	39–20
4–04	16–18	28–33	40–21
5–05	17–40	29–34	41–37
6–06	18–28	30–35	42–42
7–07	19–41	31–16	43–43
8–11	20–29	32–24	44–44
9–12	21–36	33–26	45–45
10–14	22–30	34–22	46–46
11–13	23–31	35–08	47–47
12–17	24–38	36–09	48–48
1–088/089	20–037	39–082	58–094
2–136	21–031	40–065	59–049
3–023	22–027	41–149	60–015
4–011	23–053	42–152	61–024
5–163	24–054	43–059	62–102
6–101	25–048	44–155	63–086
7–022	26–004	45–165	64–076
8–062	27–044	46–164	65–055
9–010	28–006	47–077	66–146
10–087	29–009	48–093	67–058
11–013	30–144	49–003	68–170
12–005	31–072	50–007	69–040
13–043	32–032	51–168	70–096
14–091	33–074	52–060/019	71–033
15–090	34–012	53–085	72–154
16–025	35–041	54–137	73–002
17–028	36–159	55–166	74–081
18–056	37–147	56–097	75–029
19–020	38–036	57–067	76–143

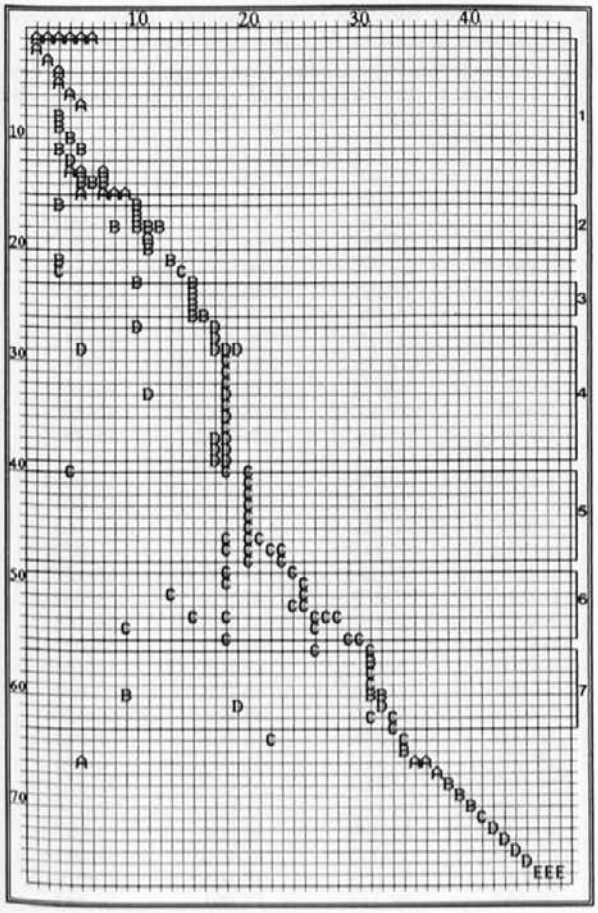
chronological boundaries. Extreme errors can occur in the chronological interpretation of the seriation table, if all of the other relationships on the site are not considered. These must also be ascertained on the basis of classical methods.

The same is exaggerated in the ranking of the attributes on the table, as seen in their chronological order. In the best case, it is in very general terms correct, but still too untrustworthy for firm support.

Both of the seriation programs form groups of carriers with the same attributes. KOR62 is quicker in this, whilst the groups are more apparent. It offers us more "good" options, from which we can choose the most siutable. Apart from this, the groups can rank in stratigraphic order, if data is available from a site, where such relationships existed. However, as large a body of carriers as possible must be available for this and it is dangerous to use them right away in the basic seriation of the material. They are only of more use at a point when we already know the groups and when we are only interested in the chronological sequence. We cannot expect more from the program at the moment. If we welcome such help, then we will use it, otherwise we will not.

Sl. 16. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 16: Sedlo on Bled Castle. Groups and membership of generations.



"IN WHICH BUSH DOES THE RABBIT HIDE"

To hope, even more – to believe that seriation programs are "objective" and, thus unconditionally trustworthy, is futile. It is more than obvious that we strongly change the results with the selection of the entry data and the formation of the entry designations.

The cleaning of the sample by mathematical rules otherwise mathematically improves the results for us, that is also all that it does. Apart from this, there are, as can be determined from the examples presented, the useful mathematical "garbage". However, it is true that clear results are only achieved with clearly selected entry data. The scale for the selection, however, must be for us our presentation of that which we seek. We must know as much as possible about the nature of the material, which we are analysing, so that we will not make too many mistakes. Or to put it another way, the program for seeking groups is merely a tool, the final success is dependant on our preparation of the entry material our ability to explain the results gained and on our working steps. If we know the rules of the seriation of archaeological material in groups, the possibility of success will be much greater. Klejn's "Archaeological Typology" (Klejn 1988, particularly 335 ss) can be of decisive help to us with regard to this. This is the bush, in which we must search.

RESULTS - CLASSICAL AND COMPUTER

The analysis of the Sedlo cemetery without the aid of a computer indicated that burials of four generations and the beginning of a fifth are present. Computer seriation divides the material in to a larger number of groups on the basis of sexual differences, chronological differences and also groups, which are based on some third element, which cannot be determined because of the small size of the sample. Computer analysis did not result in any new insights with regard to the chronological division of the material. However, it did help us in the search for further groups, which can only be defined in more detail with a larger sample of material. The great quantity (e.g. some thousand of graves or artefacts) can no longer be dealt with by "hand". The program, which rapidly seriates the material into groups, becomes indispensable, whilst we are dependant on it. If we want to use it to our advantage, we have to know how it works and what it can do.

Sl. 17. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 17: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂	♀							
B	♂	♂	♀				♂		
C				♀	♂	♂	♂		
D	♀			♀			♀		

Program za razvrščanje KOR in njegova uporabnost v arheoloških raziskavah*

Prevod

UVOD

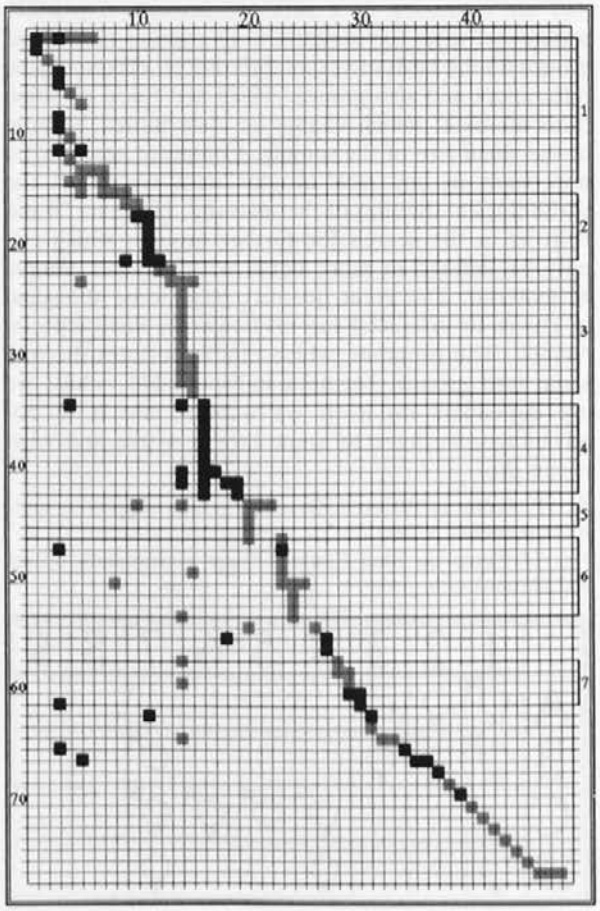
Na področju uporabe računalnika v arheologiji so zelo priljubljena tema metode razvrščanja. Predstavljati zgodovino in stanje raziskav ni naš namen, saj je samo do leta 1988 izšlo preko 117 bibliografskih enot (Herzog, Scollar 1988, 53). Zelo jedrnato zgodovino podajajo, npr. Stadler (Stadler 1984) ter Legoux in Périn (Legoux, Périn 1990).

Tu predstavljamo rezultate prvih poizkusov z domačim programom za razvrščanje KOR. Ta je v obeh svojih različicah (KOR50, KOR62) računsko precej bolj zapleten od primerljivih tujih programov, kljub temu pa še vedno zadovoljivo hiter. Poleg tega program dopušča vrsto nastavitev, s katerimi uporabnik lahko vpliva na način in intenzivnost računanja. Menimo, da je treba vsak tak program testirati na dejanskem arheološkem vzorcu. To smo tudi storili. Prvi rezultati, ki jih tu predstavljamo, okvirno kažejo na doseg takih metod razvrščanja, čeprav ni izključeno, da bo s pridobivanjem izkušenj ob razvrščanju nadaljnjih najdišč zanesljivost programa bistveno narastla.

* Raziskava poteka v okviru projekta "Vzhodne Alpe in zahodni Balkan v arheoloških dobah", katerega naročnik je Ministrstvo za znanost in tehnologijo R Slovenije.

NEKATERE DOSEDANJE IZKUŠNJE DRUGIH AVTORJEV

S stališča uporabnika je pomembno, kaj lahko od programa za razvrščanje pričakuje, koliko se lahko nanj zanese. Mnenja o tem so si med arheologi še vedno pogosto skorajda povsem nasprotujoča. Nekateri prisegajo na objektivnost programa, s katerim delajo, drugi zanikajo njegovo uporabnost. Za sredinsko presojo so se že pred dobrim desetletjem zavzeli Eggert, Kurz in Wotzka (Eggert, Kurz, Wotzka 1980, 140), ko so preverjali uporabnost razvrstilnega programa za časovno razvrščanje gradiva. Dokazali so, da matematično dober rezultat ni nujno tudi historično uporaben. Opozorili so na to, da program razvršča gradivo po skupinah. Te so v smislu časovnega zaporedja, ki so ga iskali, med seboj sicer pravilno razporejene, znotraj skupin pa je redosled poljuben, pri vsakem poizkusu drugačen. Obstajajo pa tudi "skakači" ("Springer"), ki se pridružujejo zdaj tej, zdaj oni skupini. Nastajajo iz vsaj dveh razlogov: gre za lastnosti, ki le malokrat nastopajo, ali pa za nosilce z maloštevilnimi lastnostmi. Na mejah skupin je pričakovati glede na (ne)stalnost razvrščanja določeno neostrino. Skupine naj bi bile nejasno izražene še zlasti tedaj, kadar se je gradivo skozi čas le zlagoma spreminjalo (prav tam, 137 ss).



Sl. 18. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 18: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–01	13–41	25–17	37–10
2–02	14–28	26–18	38–19
3–03	15–40	27–22	39–20
4–04	16–29	28–38	40–21
5–05	17–36	29–39	41–37
6–06	18–30	30–23	42–42
7–07	19–31	31–26	43–43
8–11	20–15	32–34	44–44
9–12	21–32	33–35	45–45
10–27	22–33	34–25	46–46
11–16	23–14	35–08	47–47
12–24	24–13	36–09	48–48
1–088/089	20–049	39–165	58–060/019
2–136	21–015	40–164	59–007
3–023	22–024	41–077	60–168
4–011	23–009	42–093	61–031
5–163	24–144	43–085	62–102
6–101	25–072	44–054	63–086
7–022	26–032	45–048	64–166
8–062	27–012	46–053	65–027
9–010	28–041	47–025	66–146
10–087	29–159	48–028	67–058
11–013	30–147	49–044	68–170
12–005	31–036	50–056	69–040
13–091	32–082	51–020	70–096
14–043	33–006	52–037	71–033
15–090	34–065	53–074	72–154
16–137	35–149	54–004	73–002
17–097	36–152	55–076	74–081
18–067	37–059	56–055	75–029
19–094	38–155	57–003	76–143

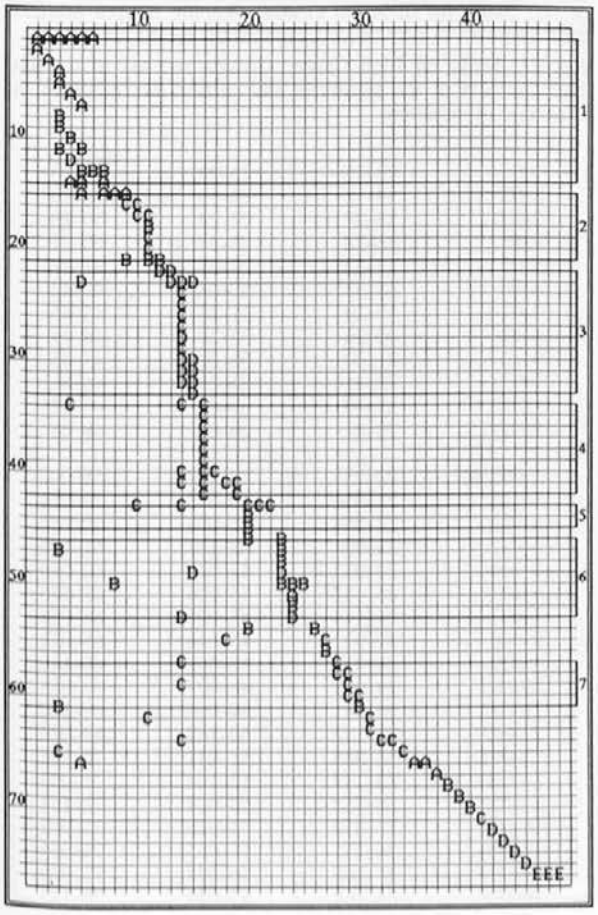
Poznane so že nekatere nevarnosti razvrščanja, ki se pojavljajo zaradi lastnosti vhodnega gradiva. Premajhna povezava lastnosti lahko povzroči preobračanje skupin (Legoux, Périn 1990). Tudi pri povezanih časovno zaporedje enako lahko preide od starejših k mlajšim in obratno, od mlajših k starejšim. Nadalje je priporočljivo obdelovati gradivo iz moških in ženskih grobov ločeno, da se ne bi tvorile skupine po spolu, morda celo v pomešanem časovnem redosledu (nasvet P. Stadlerja pri: Daim, Lippert 1984, 69). Prav tako obstaja zavest, da so skupine v gradivu lahko nastale zaradi povsem nečasovnih razlogov, npr. skupina oropanih grobov, tehnološke, sociološke razlike...(Daim 1987, 41; Roth, Theune 1988, 12; podrobno: Beinhauer 1985, 155 ss).

Večinoma skušajo avtorji z razvrščanjem iskati časovne skupine, znana pa je uporaba tudi pri določanju tipov predmetov (Legoux, Périn 1990) in predvidena za obdelavo drugih najdiščnih podatkov, npr. različnih oblik pokopov (Daim 1987, 28). Praviloma obdelujejo odbrano gradivo; to pomeni, da odstranijo vse lastnosti, ki se pojavljajo samo enkrat, in vse nosilce z eno lastnostjo, ter običajno tudi lastnosti, ki se pojavljajo v celotnem gradivu, da ne bi motile končne slike. Zelo dosledno čiščenje seveda lahko pripelje do tega, da skoraj ni ničesar, kar bi se še dalo obdelovati (Daim 1987, 41).

Le poredko avtorji govorijo o načinih opredeljevanja skupin, o njihovih mejah. Vsi jih določajo s pomočjo slike, ki jo dobijo na koncu računalniškega ali ročnega razvrščanja. Meje skupin jim določajo mesta, kjer se začenjajo ali izginjajo skupine lastnosti (lepo predstavljeno pri: Périn 1980, Fig. 73, 74). V delitev na skupine vedno pritegnejo celotno obdelano gradivo. Morda zato, ker je bilo že "očiščeno" in upajo, da so izvrgli "skakače"? Ali zaradi logične predpostavke, da pač mora nekam spadati? Pojasnila o tem delu postopka nismo našli.

Sl. 19. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 19: Sedlo on Bled Castle. Groups and membership of generations.



OPIS DELOVANJA PROGRAMOV

Namen vsakega razvrstilnega programa je, da poišče smiselna vrstna reda lastnosti ter njihovih nosilcev. V tabeli s tako urejenima seznamoma lastnosti in nosilcev lastnosti na oseh nastopajo pojavitve posameznih lastnosti na urejen način. Zbirajo se v skupine, ki nastopajo v kronološkem ali drugačnem zaporedju. Velikosti skupin so navadno različne. Prehod med zaporednima skupinama je lahko zvezen ali stopnjast. Poleg tega se med lastnosti, ki se pojavljajo le v določeni skupini lastnosti, vrivajo lastnosti, ki neselektivno nastopajo v različnih skupinah. To pomeni, da ne smemo predpostaviti zvončaste gaussovske porazdelitve gostote pojavitev znotraj posamezne skupine. Predpostavka o taki razporeditvi gostote pojavitev je implicitno prisotna v večini obstoječih korelacijskih programov. Prisotnost nenadnih rezov v razvoju posameznih bioloških in kulturno-sociooloških okolij kaže, da taki programi niso vedno najboljši za popis realnih vzorcev.

Odločilno je seveda vprašanje, kako definirati optimalna vrstna reda lastnosti ter njihovih nosilcev. V članku bomo opisali dva različna pristopa k temu problemu. V prvem, "diagonalnem" pristopu (program KOR50) je vzorec urejen, ko je vsota primerno utečenih razdalj točk, ki označujejo pojavitev lastnosti v nosilcih, od diagonale tabele minimalna. Pri tem dopuščamo, da imajo posamezne lastnosti različne uteži, tako da je obdiagonalnost točk "težkih" lastnosti višje vrednotena kot pri manj pomembnih "lažjih" lastnostih. Kot dodatno možnost program dopušča, da lahko izbrani lastnosti določimo "četrtino" tabele, v katero naj se uvrsti.

Takega minimuma razdalj od diagonale ni mogoče poiskati direktno, saj se da seznam N lastnosti napisati na N x (N-1) x ... ... x 3 x 2 x 1 = N! načinov. Pomagati si moramo s statističnim pristopom, pri čemer se zgledujemo po uporabni analogiji iz narave. Ko talino ohlajamo v kristal, se dogaja nekaj podobnega: neurejena razporeditev atomov v talini polagoma preide v urejeno kristalno mrežo v kristalu. Če imamo v talini različne atome, od katerih so nekateri težji od drugih, se bodo ti prej ustalili in "zmrznili" na svojem mestu v porajajočem se kristalu. Tudi v našem razvrstilnem programu govorimo o "temperaturi" vzorca. Na začetku urejanja je temperatura vzorca visoka. Vzorec je neurejen, visoka temperatura pa dopušča poljubne menjave v vrstnem redu lastnosti in njihovih nosilcev. Sledi "ohlajanje", ki ga izvajamo v zaporednih korakih. Vsak korak ima za 10 % nižjo temperaturo od prejšnjega. V okviru koraka izvede program naslednje operacije:

(a) naključno izbere dve lastnosti ter dva nosilca,

(b) izračuna utečene razdalje polnih točk v teh dveh lastnostih in nosilcih od diagonale,

(c) začasno zamenja ti dve lastnosti in nosilca med seboj,

(d) izračuna nove utečene razdalje kot pod (b),

(e) izračuna vrednost eksponentne funkcije, ki ima za argument razliko starih in novih razdalj, deljeno s trenutno temperaturo,

(f) če je vrednost eksponentne funkcije manjša od naključno izbranega števila v intervalu med 0 in 1, zamenjavo dejansko izvede, sicer pa ostane pri starem vrstnem redu,

(g) M-krat ponovi operacije (a) do (f),

Sl. 20. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 20: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂ ♀	♀				♀			
B	♂ ♀	♂			♀	♂ ♀	♂		
C		♂ ♀	♀	♂	♀		♂ ♀		
D	♀		♀			♀			

(h) če nobena od M menjav ni bila uspešna, ugotovi, da je vzorec zamrznjen in konča z urejanjem; sicer pa zniža temperaturo za 10% ter izvede operacije (a) do (g) v okviru naslednjega temperaturnega koraka.

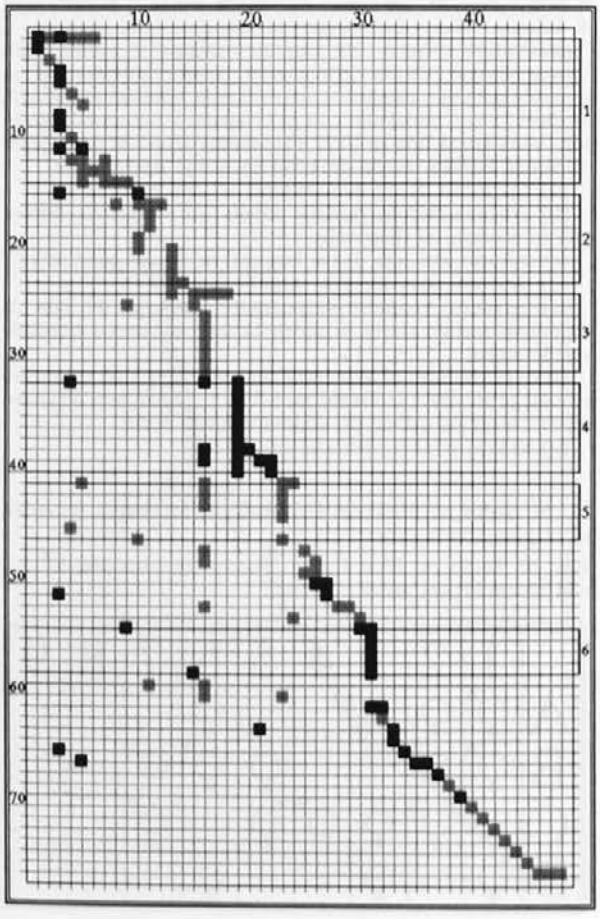
Opisana shema ima nekaj pomembnih prednosti. V prvi fazi računanja so uspešni praktično vsi poskusi menjav, tako da se hitro izniči vpliv vrstnega reda v vnešenih podatkih. Postopno ohlajanje sicer omogoča tudi nekatere menjave, ki so trenutni urejenosti vzorca v škodo, zato pa ne dopusti, da bi se urejanje končalo pri katerem od lokalnih maksimumov urejenosti ter zgrešilo globalno najugodnejšo rešitev.

Ob prednostih je treba omeniti tudi dve slabosti. Prva je čas računanja. Če je N število lastnosti oziroma njihovih nosilcev, raste čas računanja približno s četrto potenco N-ja. V praksi to pomeni, da na računalniku tipa microVax ni bilo možno urejati tabel z več kot nekaj sto členi. Kasneje smo program dodatno izpopolnili. Kandidatov za menjave (alineja a) ni več izbiral povsem naključno, ampak je dal prednost tistim, ki so pri dani temperaturi ravno "sedali" na svoja mesta v tabeli. Tudi temperaturni koraki niso bili več enaki, ampak je bila v fazi ustaljevanja vzorca v urejeno strukturo razlika med zaporednimi temperaturami manjša. S temi spremembami smo računanje pospešili približno za desetkrat. MicroVax sedaj uredi vzorec s 400 lastnostmi ter prav toliko nosilci v nekaj urah CPU časa.

Druga slabost je bolj načelne narave. Ideja, da bodo točke urejenega vzorca zbrane ob diagonali, je sicer estetsko in matematično privlačna, vendar pogosto ne ustreza dejanskemu stanju. Ker so velikosti zaporednih skupin med seboj različne, teče hrbtenica urejenega vzorca med nasprotnima ogljiščema tabele v obliki loka ali še bolj zapletene krivulje in ne naravnost po diagonali. Oblike te hrbtenice seveda ne poznamo vnaprej, zato se izplača poizkusiti z alternativnim pristopom k razvrščanju.

Ta alternativni pristop (program KOR62) imenujemo tudi "zaporedni". V nasprotju s KOR50 tu zgradimo tabelo v enem zamahu. Najprej si izberemo začetni nosilec. Na drugo mesto uvrstimo tistega, katerega lastnosti se najbolje ujemajo z lastnostmi prvega nosilca. Kot treji sledi nosilec, ki najbolje korelira s prvima dvema, in tako dalje, dokler niso uvrščeni vsi nosilci. Nosilec, ki najbolje korelira z že uvrščenimi lastnostmi, je tisti, ki ima največjo dinamično težo. Ta je definirana kot vsota tež tistih v nosilcu prisotnih lastnosti, ki so že uvrščene. Pri tem nedavno uvrščene lastnosti štejejo več, mnogo prej uvrščene lastnosti pa manj. Kaj štejemo kot nedavno uvrščeno lastnost, pove pričakovana velikost skupine, parameter, ki ga moramo vstaviti pred začetkom računanja. Končno je vsota že uvrščenih lastnosti zmanjšana za delež v nosilcu prisotnih lastnosti, ki še niso bile uvrščene v tabeli. Program dopušča tudi možnost, da mu v vhodnih podatkih določimo, kateri nosilci naj bodo v tabeli uvrščeni prej in kateri pozneje. S specifikacijo takih "prej:pozneje" parov lahko dosežemo, da bodo, npr. zgodnji grobovi uvrščeni pred tistimi iz kasnejšega obdobja.

Prednost tega pristopa je dvojna. Na uvrstitev določenega nosilca vpliva le njegova povezava z že uvrščenimi nosilci. To je bolj smiselno od "diagonalnega" kriterija (program KOR50), primernega za idealno urejene vzorce, podobne pravilnim kristalom, ki se jim realni arheološki vzorci ne približajo. Poleg tega je zahtevnost računanja bistveno manjša in zato hitrost razvrščanja mnogo večja kot pri programu KOR50. Računanje lahko ponovimo z različnimi začetnimi nosilci in rezultate primerjamo med seboj. Program tudi lahko samostojno oceni, kateri izid je najbolj smiseln. Trenutno izbere tistega, ki ima največjo vsoto dinamičnih tež posameznih nosilcev ob njihovi uvrstitvi v tabelo. Ta kriterij je smiseln, vendar verjetno ne optimalen. V bližnji prihodnosti nameravava preizkusiti tudi druge možnosti za izbor optimalnega izida razvrščanja. Upati je, da bo to povečalo kvaliteto dobljenih rezultatov.



Sl. 21. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 21: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–01	13–15	25–38	37–10
2–02	14–18	26–39	38–19
3–03	15–27	27–23	39–20
4–04	16–28	28–34	40–21
5–05	17–32	29–35	41–37
6–06	18–33	30–24	42–42
7–07	19–29	31–16	43–43
8–11	20–36	32–26	44–44
9–12	21–30	33–22	45–45
10–14	22–31	34–25	46–46
11–13	23–40	35–08	47–47
12–17	24–41	36–09	48–48
1–088/089	20–053	39–077	58–097
2–136	21–054	40–093	59–074
3–023	22–048	41–009	60–082
4–011	23–004	42–147	61–102
5–163	24–085	43–036	62–086
6–101	25–137	44–006	63–076
7–022	26–144	45–005	64–055
8–062	27–072	46–044	65–027
9–010	28–032	47–003	66–146
10–087	29–012	48–007	67–058
11–013	30–041	49–060/019	68–170
12–043	31–159	50–168	69–040
13–091	32–065	51–031	70–096
14–090	33–149	52–166	71–033
15–025	34–152	53–024	72–154
16–056	35–059	54–015	73–002
17–020	36–155	55–067	74–081
18–037	37–165	56–094	75–029
19–028	38–164	57–049	76–143

VHODNA DOLOČILA, VHODNA IN IZHODNE DATOTEKE

Vhodna datoteka za KOR50 je sestavljena iz treh delov. Prvi je seznam nosilcev z lastnostmi, ki jih vsebujejo. Drugi je seznam lastnosti z utežmi od 1 do 100 (cela števila), tako kot smo jih določili sami. Tu lahko tudi označimo četrtino tabele, v katero naj bo lastnost uvrščena. Tretji del je seznam vrednosti posameznih razdalj od osi. Tudi to morajo biti cela pozitivna števila. Najboljši rezultat daje linearno padanje vrednosti za ena. Vrednosti mora biti najmanj toliko, kot je največ vhodnih podatkov številčnejše vrste (nosilcev ali lastnosti). Pri KOR62 je ta tretji del zamenjan s seznamom nosilcev, ki so si v odnosih prej:pozneje. Mišljeno je, da sem vnesemo podatke o plastenju najdiščnih skupkov.

Obe različici programa omogočata uporabniku nastavitev še nekaterih vhodnih določil za računanje. Pri KOR50 lahko določimo intenzivnost mešanja, ki pomeni, v povprečju koliko premikov določene lastnosti naj program testira pri vsaki vrednosti temperature. Enkrat večja intenzivnost pomeni tudi toliko daljši čas računanja, vendar ne sme biti premajhna, sicer vzorec prehitro zamrzne. Nadalje lahko določimo, koliko naj bodo medsebojne razdalje za testiranje zamenjave izbranih nosilcev razmazane okrog povprečne vrednosti. Večinoma najboljše so vrednosti med 2.0 in polovico vrednosti intenzivnosti mešanja. Imamo dve možnosti, da zmanjšamo čas računanja. Začnemo lahko z nižjo začetno temperaturo ali pa povečamo hitrost ohlajanja, vendar vsako tovrstno pospeševanje slabša rezultate.

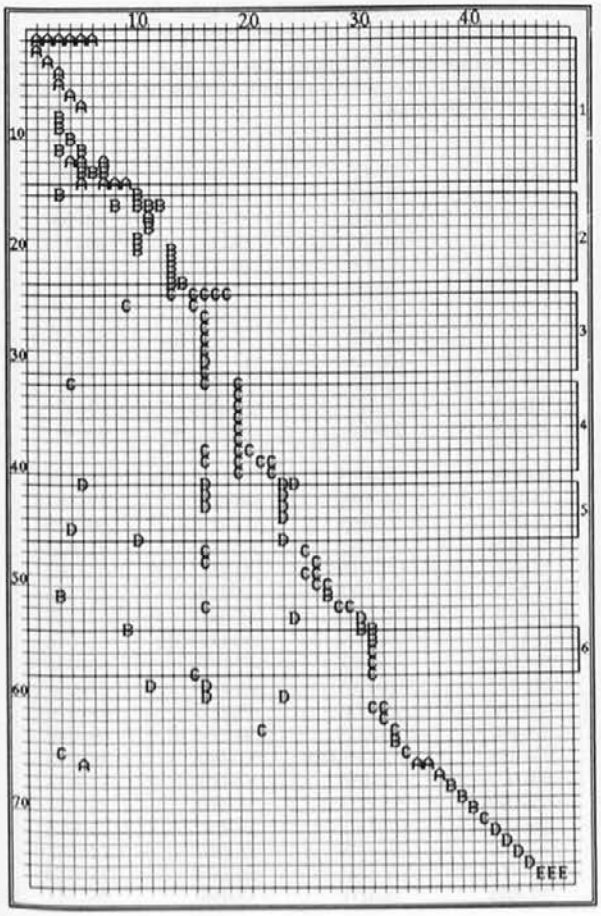
Pri KOR62 so vhodna določila seveda drugačna. Določamo mero za velikost skupine. Izbiramo lahko različne načine uteževanja. Teže lastnosti so lahko vse enake, ne glede na število pojavitev, sorazmerne s številom pojavitev, obratno sorazmerne s številom pojavitev, ali pa take kot smo jih določili v vhodni datoteki. Trenutno se zdi najbolj primerna utežitev, ki je sorazmerna številu pojavitev. Lastnosti, ki se večkrat pojavijo, so težje od maloštevilnih. Predvsem pa različne uteži vplivajo na izbiro začetnega nosilca. Imamo namreč možnost, da začetni nosilec določimo sami in naredimo le eno razvrščanje, ali pa izbor prepustimo računalniku ter mu ukažemo, naj kot začetne preizkusi vse nosilce, katerih teža presega dani % teže najtežjega nosilca. Poizkusni vzorec je dal najboljše rezultate pri vrednostih okoli 50 %. Zadnja možnost je, da program, če želimo, upošteva tudi odnose prej:pozneje.

Program KOR50 ima dve izhodni datoteki: *.par in *.rez. Prva vsebuje koordinate točk, ki označujejo prisotnost lastnosti v nosilcih. Druga vsebuje seznam lastnosti, njihovo zaporedje v tabeli, zaporedna mesta v zadnjih 22 temperaturnih korakih, povprečno zaporedno mesto teh korakov in povprečno odstopanje od tega mesta. Pri vsakem razvrščanju nastane več *.par in *.rez datotek, ki omogočajo spremljati oblikovanje skupin. Drugače je pri programu KOR62. Ta ima tri izhodne datoteke: *.la, *.no in *.par. Zadnja je enaka kot pri prejšnjem programu. V datoteki *.la so navedene lastnosti, njihova zaporedna mesta in število pojavitev. V datoteki *.no so nosilci in njihova zaporedna mesta, število vsebovanih lastnosti, skupna teža lastnosti, dinamična teža ob trenutku uvrstitve, število novih lastnosti, ki jih je nosilec prinesel pri uvrstitvi, ter oznaka o morebitni vključenosti nosilca v zveze "prej:pozneje".

Oba programa omogočata tudi spremljanje sprotnega poteka razvrščanja, ki je shranjeno v posebni datoteki, če delamo v paketni obdelavi. Pri KOR62 tako lahko hitro izluščimo najbolj obetavne začetne nosilce.

Sl. 22. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 22: Sedlo on Bled Castle. Groups and membership of generations.



ZBIRANJE LASTNIH IZKUŠENJ

Da bi ugotovili primerljivost z dosedanjimi razvrstilnimi programi, smo s svojim programom ponovno obdelali jagode iz alamanskega grobišča Weingarten. Te so bile že obdelane s programom P. Ihma (Theune-Vogt 1990, 4), na katerega sta se naslonila tudi Herzogova in Scollar pri razvoju BAS paketa (Herzog, Scollar 1987, 274), ki je trenutno med arheologi verjetno najbolj razširjen. Slika, ki je bila narejena s KOR50, je bila zelo podobna tisti, ki jo objavlja C. Theune – Vogt (prav tam, Abb. 1). Naš postopek je bil pri tem izpeljan v različici, v kateri so bile lastnosti brez teže. Taka podobnost nam pomeni, da sta programa in njuni rezultati primerljiva.

Siceršnje vadišče za naš program je bilo bajuvarsko grobišče Altenerding, razvrščanje tamkajšnjih jagod in pasnih spon. Sčasoma se je pokazala potreba po obdelavi gradiva, kjer bi morali biti rezultati že znani, da bi bili učinki programa bolj razvidni. Izdelali smo umeten vzorec, ki je poskušal poenostavljeno oponašati resnični arheološki vzorec, a se je izkazalo, da pravega gradiva ne more povsem nadomestiti. Zato smo izbrali kot preizkusni primer še staroslovansko grobišče Sedlo na Blejskem gradu.

Sl. 23. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 23: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♂♀	♀							
B	♂♀	♂♀				♂			
C			♀	♂		♂			
D			♀		♀				

DOLOČANJE SKUPIN

Najprej si poglejmo, kako je pri KOR50. Običajni način določanja skupin s pomočjo kombinacijske tabele je bil že omenjen. Vendar ima ta način poleg vsebinske tudi druge pomanjkljivosti. Veliko število povsod prisotnih lastnosti sliko seveda krepko zamegli. A če pristanemo na "čiščenje", jih seveda lahko odstranimo in dobimo lepšo sliko. Težje je, kadar se odločimo, da bomo lastnosti začeli oteževati, ker menimo, da so nekatere za namen našega razvrščanja bolj pomembne kot ostale. Tedaj v končni sliki te lastnosti sicer tičijo tesno ob diagonali, ostale pa so krepko razpršene po prostoru. Tu dosedanja merila za določanje skupin odpovedo.

Rešitev izhaja iz načina delovanja programa. Najprej se usedejo nosilci z najtežjimi lastnostmi in tako postanejo kristalizacijska jedra skupin, okoli njih se nabirajo lažji nosilci. Ker imamo v izhodni datoteki *.rez podatke o mestih, kamor je program postavljal nosilce v zadnjih temperaturnih korakih, si lahko s tem pomagamo. Opazujemo, na katerih mestih so "nihali" nosilci. Težki se trdno držijo svojih mest, lažji plešejo gor in dol, a le v določenem področju. Obstajajo mesta, ki jih nosilci ne presegajo, niti tisti iz zgornje niti tisti iz spodnje skupine. Ta mesta so meje skupin. Skupina je sestavljena tako, da so v njeneme jedru težji nosilci, lažji pa na njenih mejah, ker tam program najmanj motijo. Najlažje nosilce, ki z drugimi nimajo dobrih povezav, program odlaga na začetek ali konec diagonale, ker tam najmanj motijo sliko. Podobno se dogaja lastnostim, ki se pojavljajo skozi celoten vzorec. Te program postavlja na začetek, konec ali sredino, ker ga tam najmanj motijo. Na sami sliki opazimo, da se meje skupin, ki smo jih določili s pregledom nihajnih področij nosilcev, praviloma ujemajo z vodoravnimi motnjami, ki nastopajo v tabeli. Te povzročajo lahki nosilci – "smeti", ki jih program tlači med skupine, ker ga tam najmanj motijo. Tako nam torej smeti z lepo vidnimi motnjami pomagajo določati skupine.

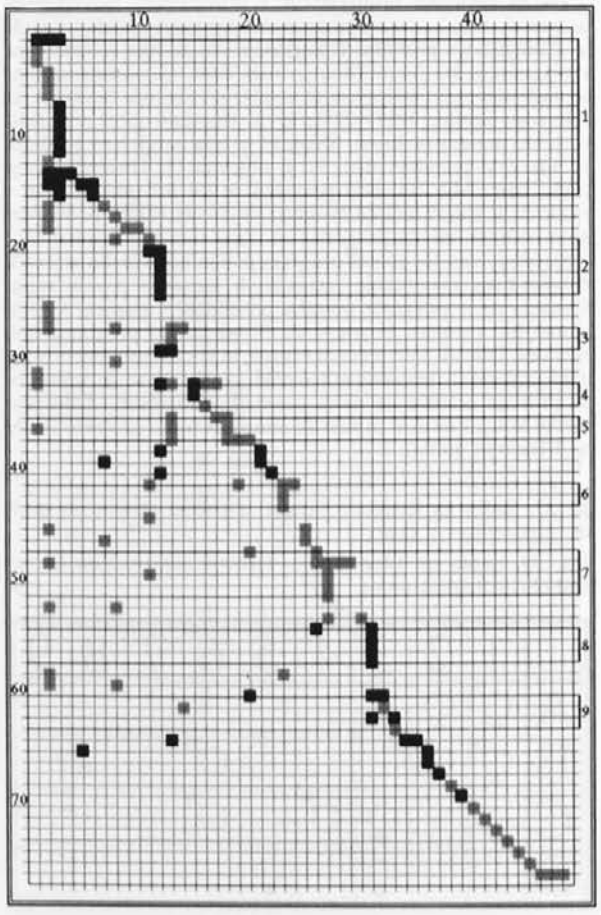
Ugotavljanje skupin pri KOR62 je bolj preprosto. Program išče nosilce, ki so si po svojih lastnostih kar najbolj podobni. V izhodni datoteki *.no imamo podatke o tem, koliko novih lastnosti je prinesla uvrstitev posameznega nosilca in kolikšna je stopnja njegovega ujemanja s prejšnjimi nosilci, izražena z dinamično težo. Vstop novih lastnosti ob hkratnem zmanjšanju ujemanja je znak nove skupine. Seveda se lahko vprašamo, koliko novih lastnosti že pomeni novo skupino. Odgovor je dovolj zoprn, da stvari ne poenostavi: dovolj je ena sama, če je tista, za katero menimo, da je pomembna. Lahke nosilce program dodaja težjim, če se po svojih lastnostih z njimi ujemajo. Tako se na tabeli lepo izrazijo večje skupine. Preostale "smeti", ki nimajo nobenih povezav, program odloži na konec. Lahko bi rekli, da jih pospravi na kup. Tudi v tem programu so torej smeti uporabne: poudarijo nekatere skupine, neuporabljeni ostanek je lepo razviden na koncu. Na tabeli zaradi vstopa novih lastnosti nastajajo stopničke, ki označujejo meje skupin.

Za razlago tabel pri obeh programih velja, da vanjo ne smemo na vso silo tlačiti vseh nosilcev, saj bomo sicer pobrali tudi vse smeti.

O PREDSTAVLJENEM VZORCU

Za grobove na Sedlu je značilno kopičenje v navpičnih plasteh ob hkratni težnji vsakokratnega pokolenja, da bi bili pokopi vendarle v vrstah. Na tej podlagi in ob soupoštevanju oblikovnih ujemanj predmetov v grobovih je bilo mogoče grobišče razčleniti na štiri pokolenja (A – D) ter jih na koncu predstaviti v tabeli (Pleterski 1982, sl. 5). To smo vzeli za primerjalno izhodišče, ker odraža dejanski razpored gradiva skozi čas, saj so bile časovne skupine določene s plastmi in ne tipološko- kombinacijsko.

V primerjavi z originalno tabelo smo tretjemu pokolenju



Sl. 24. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 24: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–04	13–05	25–38	37–10
2–28	14–41	26–27	38–19
3–29	15–01	27–15	39–20
4–36	16–02	28–32	40–21
5–30	17–06	29–33	41–37
6–31	18–07	30–18	42–42
7–39	19–11	31–16	43–43
8–40	20–12	32–24	44–44
9–34	21–23	33–26	45–45
10–35	22–25	34–08	46–46
11–14	23–13	35–09	47–47
12–03	24–17	36–22	48–48
1–065	20–025	39–168	58–074
2–101	21–011	40–027	59–082
3–087	22–163	41–056	60–015
4–144	23–062	42–020	61–024
5–072	24–010	43–037	62–102
6–032	25–012	44–028	63–086
7–149	26–159	45–003	64–146
8–152	27–009	46–060/019	65–076
9–059	28–022	47–137	66–055
10–155	29–013	48–085	67–058
11–165	30–006	49–053	68–170
12–041	31–005	50–054	69–040
13–164	32–088/089	51–048	70–096
14–077	33–136	52–036	71–033
15–093	34–023	53–004	72–154
16–007	35–091	54–097	73–002
17–147	36–043	55–067	74–081
18–166	37–090	56–094	75–029
19–044	38–031	57–049	76–143

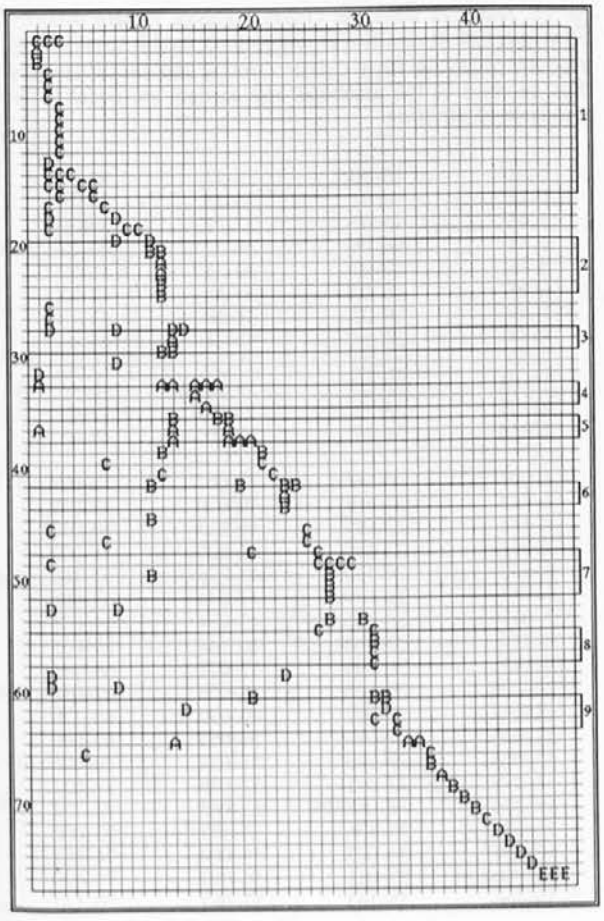
pripisali še nosilce 012, 159, 060/019 in 007, ki izboljšujejo razmerje med moškimi in ženskami, ne da bi nasprotovali osnovnim kriterijem uvrstitve. Nosilca 143, ki bi sicer lahko pripadal še času četrtega pokolenja, smo označili posebej (E), ker zaradi bijelobrdskega uhana že nakazuje novo pokolenje, ki na tem grobišču ni bilo več pokopano.

Ker podrobna antropološka obdelava okostij še ni končana, je spol pokojnikom določen po značilnih pridatkih: nož, jelenji parožek, kovinski obroč pri pasu, okostje svinje, ki so v moških grobovih. Taki opredelitvi ne nasprotujejo antropološki podatki istočasnih sosednjih grobišč. Seveda ni nujno, da tako dobljena slika povsem odslikava resnico, vendar je dovolj trdna za prepoznavne izsledke.

Pri gradivu s Sedla namenoma nismo ločili moških in ženskih grobov. Pričakovali smo, da bo program razvrstil gradivo skupine moških in skupine ženskih grobov; zanimala nas je njihova medsebojna razporeditev. Zavedati se je namreč treba, da tudi v okviru istospolnih grobov lahko nastajajo različne skupine, ki so lahko časovno povedne ali pa tudi ne. Ali jih bomo znali razbrati? Moški in ženske so nam le simbol manj očitnih vzrokov nastajanja skupin. Prav tako smo pustili gradivu vse "smeti": lastnosti, ki se pojavijo le enkrat, in nosilce s samo eno lastnostjo. Ne smemo si namreč domišljati, da bi s tem merilom izločili vse, kar program občuti kot smet. Ker nismo izvrgli jasno razvidnih, je bilo mogoče opazovati, kaj program z njimi počne in tako predvideti, kaj in kje so skrite "smeti".

Sl. 25. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 25: Sedlo on Bled Castle. Groups and membership of generations.



SPLOŠNO O SLIKAH

Vse slike, ki jih predstavljamo, so razvrščanja gradiva z grobišča Sedlo. Prevzeli smo številke grobov, ki nam predstavljajo nosilce, in od 01 do 48 oštevilčili predmete iz grobov, ki nam predstavljajo lastnosti (*t. 1*). Posamezni poizkusi so predstavljeni na tri načine.

Prva je tabela, kjer vsak kvadratek pomeni lastnost (= predmet) posameznega nosilca (= groba). Črna barva pomeni moške grobove, siva pa ostale, praviloma ženske. Nosilec 088/089 je obravnavan kot par moža in žene. Vodoravna številčnica vrh tabele kaže zaporedna mesta lastnosti, navpična pa zaporedna mesta nosilcev. Na katerem mestu je posamezna lastnost ali posamezen nosilec, je razvidno iz sosednjih številčnih stolpcev, ki kažejo najprej razvrstitev lastnosti in nato še nosilcev.

Naslednja tabela je v osnovi enaka, le da so na mesto kvadratkov vnesene črke: A, B, C, D, E. Vsaka črka pomeni pokolenje, ki mu posamezni nosilec pripada.

Tretja razpredelnica ima s številkami označene skupine nosilcev, kot jih je bilo mogoče razbrati s pomočjo razvrščanja, črke pa označujejo pokolenja, v katerih te skupine nastopajo. Simboli za moške in ženske kažejo pripadnost posamezne skupine nosilcev določenemu spolu v posameznem pokolenju.

PRIMERI

Gradivo s Sedla je dovolj maloštevilno, da je pregledno, hkrati pa se pri njem že vsaj nakazujejo pojavi, ki se sicer mnogo bolje odrazijo pri velikih vzorcih. *Sl. 1* je začetno primerjalno stanje, likovno nekoliko predelana tabela iz leta 1982. *Sl. 2* kaže pokolenja, ki jim pripadajo nosilci. Sliki v kar največji možni meri odražata dejansko stanje; to kar bi lahko opredelili kot skupine, je razmeroma neurejeno, nekatere lastnosti so neodvisno od svoje številčnosti močno razpotegnjene skozi čas. Različne skupine vsaj delno nastopajo istočasno, v pokolenju D ni več moških grobov s pridatki, najverjetneje zaradi opuščanja starih pogrebnih običajev.

Naslednje tri skupine slik kažejo razvrstitve, narejene z "diagonalnim" programom KOR50. Vsa vhodna določila so bila ves čas enaka, da bi bil jasnejši vpliv tistih, ki jih pri vsakem primeru posebej navajamo. *Sl. 3* je nastala pod vplivom naslednjih vhodnih določil: lastnosti so bile utežene v skladu s presojo o njihovi večji ali manjši časovni občutljivosti, področje (četrtina) uvrstitve jim ni bilo določeno. Vidna je jasna črta diagonale, ki jo sestavljajo težke lastnosti, lahke so precej bolj razpršene. Število skupin je razmeroma veliko, razporeditev po spolu ne preveč izrazita. Smeti so na začetku in koncu ter deloma med posameznimi skupinami. *Sl. 4* kaže, da je v časovnem pogledu razporeditev precej premetana. Značilno je, da smeti tudi časovno odstopajo od siceršnje časovne pripadnosti skupin, na katere mejijo. Pomembna je uvrstitev groba 143 (pokolenje E) na 21. mesto med skupini 2 in 3. Tam nastopa kot smet, ker nima z ostalim gradivom nobenih povezav. Tudi če bi bila to skupina, bi se ji zelo verjetno godilo podobno. Pri delu z umetnim vzorcem se je

Sl. 26. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 26: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♀	♂	♀	♂	♀	♀			
B	♀	♂	♂		♀	♀	♀	♂	♂
C	♂						♀	♂	♂
D	♀	♀	♀						♀

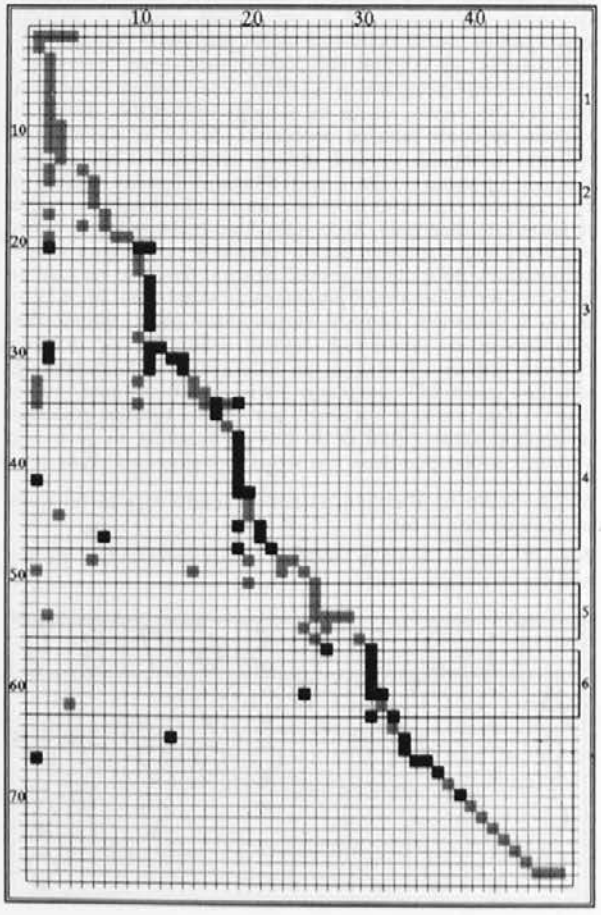
zelo jasno pokazalo, da sicer nastajajo po vsebini vedno enake skupine, da pa so si, če je med njimi premalo povezav, med seboj v povsem poljubnem redosledu, skoraj pri vsakem poskusu drugačnem. Zato je pri takih skupinah dokazovanje časovnega redosleda več kot tvegano. *Sl. 5* kaže, da nobena skupina ne pripada samo enemu pokolenju, ampak najmanj dvema, lahko pa celo štirim. Še pomembneje je, da skupine nastopajo celo raztrgano skozi čas (npr. skupine 6, 8, 9). Dve skupini pripadata samo enemu spolu (2, 9), pri ostalih pa se kaže zanimiv pojav. Moški nosilci se v njih pojavljajo prej kot pa ženski, kar bi lahko pomenilo, da se časovna členitev moških grobov ne ujema z ženskimi. Ali drugače povedano, treba je resno pretresti možnost, da iste lastnosti ne nastopajo vedno istočasno pri moških in ženskah, ampak da prihaja do zamikov.

Vhodna določila, ki so vplivala na *sl. 6* so bila enaka kot pri prejšnjem poizkusu, le da so bile lastnosti brez teže. Osredotočenost lastnosti ob diagonali je sedaj bistveno večja kot prej, skupin je manj kot prej, a so bolj strnjene in opazno deljene po spolu. Tudi tu so smeti na začetku in koncu ter deloma med skupinami. Kot kaže *sl. 7* pa so skupine časovno krepko pomešane, smet – nosilec 143 je potisnjen na 11. mesto med skupini 1 in 2. Skupine so krepko razvlečene skozi čas (*sl. 8*), delno celo raztrgane (2, 3). Pripadajo samo enemu spolu, razen dveh skupin (2, 6), kjer se moški nosilci pojavljajo le v začetnih pokolenjih, potem pa ne več.

Zadnji poizkus z "diagonalnim" programom (*sl. 9*) je imel pri vhodnih določilih prav tako lastnosti brez teže, pač pa smo nekaterim lastnostim določili četrtino tabele, v katero naj jih uvrsti: lastnosti 01 – 06 v prvo četrtino, 40, 41, 48 pa v zadnjo četrtino. Zaradi splošnih izkušenj smo predpostavili, da so prve stare in druge mlade. Število skupin je enako kot prej, v grobem imajo tudi enako vsebino. Prav tako je očitno tvorjenje skupin po spolu. Tudi tu je nekaj smeti na začetku in koncu ter deloma med skupinami. Zanimivo je, da se je nosilec 143 vrinil v prvo skupino z lastnostima brez določene četrtine, določena lastnost pa plava daleč od diagonale, da lahko stoji na začetku zadnje četrtine. Pogoj o zadnji četrtini je bil očitno prešibek, da bi tudi nosilec sam zašel na dno tabele. Prva vidna razlika s prejšnjo tabelo (*sl. 6*) je ta, da dolgi stolpički lastnosti ne nastopajo samo na koncih in predvsem v sredini, ampak bolj raztreseno. *Sl . 10* kaže v grobem pravilno gibanje od starejših k mlajšim skupinam. Lepo je to razvidno na *sl. 11*. Najprej se zvrstijo tri starejše skupine, četrta gre skozi ves čas in nato še dve mlajši. Delitev po spolu je rahlo manj izrazita. Še vedno pa v mešanih skupinah moški nosilci nastopajo večinoma prej kot ženski. Skupine seveda segajo skozi več pokolenj, a niso raztrgane.

Ostali primeri so bili narejeni s programom KOR62 za "zaporedno" razvrščanje. *Sl. 12* kaže tabelo, ki je bila narejena z naslednjimi vhodnimi določili: časovno občutljivejše lastnosti so bile bolj obtežene, velikost skupine lastnosti je 12, za začetek je določen par grobov 088/089. Razvidnih je sedem skupin, ki se precej delijo po spolu; izrazito mešana je prva, ker je uvodni par moški in ženski nosilec. Smeti so razvrščene deloma med skupinami, predvsem pa na koncu. Ker je uvodni nosilec iz najstarejšega pokolenja (*sl. 13*), je uvodna skupina večinoma stara, le nosilec 005 na 12. mestu pripada pokolenju D. Sledi hiter prehod k mlajšim skupinam, ki so časovno premešane. To kaže tudi *sl. 14*, kjer je jasno, da sta skupini 1 in 5 v času raztrgani. Skupine 3, 4, 6 pripadajo le enemu spolu, pri ostalih pa moški in ženski nosilci nastopajo časovno deloma zamaknjeno, npr. skupina 2.

Pri poizkusu na *sl. 15* so bila vhodna določila enaka kot prej, le teža vseh lastnosti je bila sorazmerna številu pojavitev. Vsebina skupin v grobem ostaja podobna, le njihova medsebojna razporeditev je drugačna. Smeti so delno med skupinami, predvsem pa na koncu. Grobi časovni razpored (*sl. 16*) gre od starejših k mlajšim skupinam. Skupine 3 – 5 pripadajo samo enemu spolu (*sl. 17*), 3, 5, 6 pa prvikrat samo enemu pokolenju. Tudi tu je časovni zamik moških in ženskih nosilcev znotraj iste skupine (npr. skupina 7).



Sl. 27. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 27: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–05	13–30	25–12	37–10
2–28	14–31	26–15	38–19
3–40	15–07	27–27	39–20
4–41	16–06	28–32	40–21
5–38	17–01	29–33	41–37
6–13	18–02	30–18	42–42
7–39	19–03	31–16	43–43
8–34	20–14	32–24	44–44
9–35	21–23	33–26	45–45
10–04	22–25	34–22	46–46
11–29	23–11	35–08	47–47
12–36	24–17	36–09	48–48
1–009	20–065	39–062	58–094
2–022	21–101	40–010	59–049
3–144	22–087	41–013	60–015
4–072	23–149	42–025	61–024
5–032	24–152	43–028	62–102
6–012	25–059	44–044	63–086
7–041	26–155	45–031	64–076
8–159	27–165	46–168	65–055
9–147	28–005	47–027	66–146
10–036	29–164	48–056	67–058
11–082	30–077	49–090	68–170
12–006	31–093	50–053	69–040
13–003	32–043	51–054	70–096
14–074	33–091	52–048	71–033
15–020	34–088/089	53–085	72–154
16–037	35–136	54–137	73–002
17–007	36–023	55–004	74–081
18–060/019	37–011	56–097	75–029
19–166	38–163	57–067	76–143

Poizkus z lastnostmi z enako težo (*sl. 18*) je dal na oko morda za las lepše skupine, ki so še vedno deljene po spolu, časovno (*sl. 19*) pa bolj pomešane kot prej, kar kaže tudi *sl. 20*. Le skupina 4 pripada enemu pokolenju.

Pri zadnjih treh poizkusih ni bila uporabljena možnost vhodnega določila, ki upošteva med nosilci odnose prej : pozneje. Pri naslednjem (*sl. 21*) pa je bila vključena tudi ta možnost, velikost skupine lastnosti je bila 7, lastnosti otežene sorazmerno s številom pojavitev. Skupine so malo manj razvidne, precej razdeljene po spolu, smeti so deloma med njimi, predvsem pa na koncu. Časovno so lepo razporejene od starejših k mlajšim z motnjo na koncu (*sl. 22*), kar kaže tudi *sl. 23*. Skupine 3 – 6 pripadajo nosilcem enega spola, skupini 4 in 5 pa enemu pokolenju. Tokrat se je prvič oblikovala skupina, ki pripada le pokolenju D – skupina 5. Odnosi prej : pozneje, ki odražajo stratigrafsko lego, so tako močno vplivali na pravilni redosled in celo izrazili posebnost pokolenja D, ki je bilo doslej vedno primešano ostalim skupinam. Ker je bilo odnosov prej : pozneje premalo, je ostal del gradiva zunaj njih, kar je vidno kot smeti med 5 in 6 skupino ter skupina moških grobov 6, ki v te odnose ni vključena.

Še lepše kaže dvoreznost možnosti prej : pozneje *sl. 24*. Edina vhodna sprememba s prejšnjim poizkusom je, da je bil za začetek izbran drug nosilec, v tem primeru 065 iz pokolenja C. Močna je le prva skupina, ostale so močno razdrobljene, a še vedno precej urejene po spolu. Med njimi je veliko smeti, ostale so na koncu. Časovno so skupine krepko pomešane (*sl. 25*). Začetek je mlajši, nato krčevit prehod k starejšim skupinam in nato pravilnejše nadaljevanje k mlajšim (*sl. 26*). Le skupina 4 pripada samo enemu pokolenju.

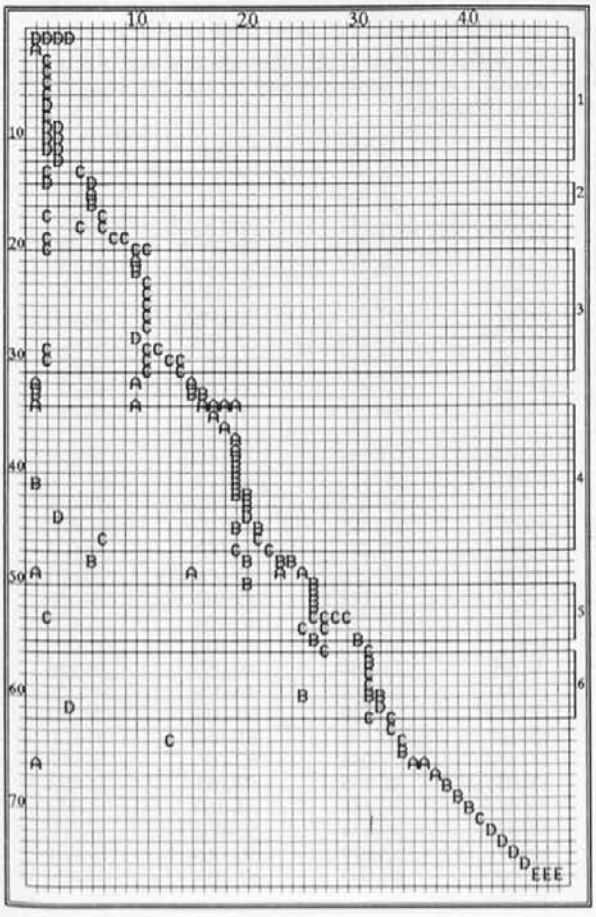
Naslednji poizkus (*sl. 27*) ima enaka vhodna določila kot prejšnji, le da ne uporablja možnosti prej : pozneje, začenja pa z najtežjim nosilcem 009 iz pokolenja D. Skupin je bistveno manj, so lepo vidne in izrazito razdeljene po spolu. Časovna razporeditev (*sl. 28*) je močno pomešana. Vse obsegajo več pokolenj (*sl. 29*). Tri skupine so samo ženske, ostale so mešane; moški in ženski nosilci v njih nastopajo časovno zamaknjeno.

Ker je možnih začetkov razvrščanja toliko kot je nosilcev, je koristno uporabiti izbor, ki ga ponuja program. Ta glede na določeno težo nosilcev, preizkuša enega za drugim in predlaga matematično najboljšo možnost. Takšno kaže *sl. 30*. Dvojico nosilcev 088 in 089 smo tu predhodno razstavili, mero za velikost skupine pa zmanjšali na 5. Ostala vhodna določila so bila enaka kot prej. Delitev po spolu je sedaj povsem izrazita. Nosilce, ki ne tvorijo večjih skupin, smo iz presoje izpustili. Časovna razporeditev (*sl. 31*) kaže, da je začetek v tretjem pokolenju C. Skupine skozi čas nekako nihajo (*sl. 32*).

Vendar med "najboljšimi" začetki tiči tudi tisti, za katerega bi bilo mogoče reči, da našim željam bolj ustreza (*sl. 33*). Vsebinsko so skupine seveda podobne tistim iz prejšnjega poizkusa. Ureditev po spolu je enako izrazita. Je pa bolj pravilna časovna razporeditev skupin (*sl. 34*), ki gre od starejših k mlajšim. Vendar tudi tu zadnji dve skupini (*sl. 35*) nista iz povsem najmlajšega pokolenja, pač pa kar dve skupini (4, 5) pripadata enemu pokolenju in vse enemu spolu, kar je tudi posledica strožjih meril za opredelitev skupin. Zanimivo je, da se je tudi pri tem poizkusu izoblikovala samostojna skupina najmlajšega pokolenja D.

Sl. 28. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 28: Sedlo on Bled Castle. Groups and membership of generations.



UGOTOVITVE

Skupine se med seboj časovno vsaj deloma prekrivajo, zato meja med njimi ne moremo enačiti s časovnimi mejami. Brez upoštevanja vseh ostalih odnosov na najdišču, ki jih moramo ugotavljati tudi z vsemi ustaljenimi metodami, je časovno tolmačenje razvrstilne tabele lahko močno napačno.

Enako pretirano je v zaporedju lastnosti na tabeli videti njihov časovni redosled. V najboljših primerih je v grobih obrisih sicer pravilen, a še vedno premalo zanesljiv za trdno oporo.

Oba razvrstilna programa sestavljata skupine nosilcev z enakimi lastnostmi. KOR62 je pri tem hitrejši, skupine pa bolj razvidne. Ponuja nam več "dobrih" možnosti, med katerimi si lahko izberemo najustreznejšo. Poleg tega lahko skupine razporedi v stratigrafsko zaporedje, če imamo na voljo gradivo z najdišča, kjer so taki odnosi bili. Vanje pa mora biti vpeto čim večje število nosilcev, poleg tega jih je nevarno uporabiti že v osnovnem razvrščanju gradiva. Bolj koristijo šele tedaj, ko skupine že poznamo in nas zanima le še njihov časovni redosled. Več od programov trenutno ne moremo pričakovati. Če nam je tovrstna pomoč dobrodošla, ju bomo uporabljali, sicer ne.

Sl. 29. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 29: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A	♀	♀	♀	♂					
B		♀	♀	♂	♀	♂			
C	♀		♂	♂	♀	♂			
D	♀	♀	♀	♀		♀			

V KATEREM GRMU TIČI ZAJEC

Upati, še več, verjeti, da so razvrstilni programi "objektivni" in zato brezpogojno zanesljivi, je jalovo. Več kot očitno je, da z izbiro vhodnih podatkov in nastavitvijo vhodnih določil krepko spreminjamo rezultate.

Čiščenje vzorca po matematičnih načelih nam sicer matematično olepša rezultat, to pa je tudi vse. Poleg tega so, kot je razvidno iz prikazanih primerov, matematične "smeti" lahko povsem koristne. Res pa je, da jasne rezultate dobimo samo z jasno izbranim vhodnim gradivom. Merilo za izbor nam mora biti naša predstava o tem, kar iščemo. Da pri izboru ne bi naredili preveč napak, moramo kar največ vedeti o naravi gradiva, ki ga obdelujemo. Ali drugače povedano: program za iskanje skupin je samo orodje in od naše priprave vhodnega gradiva, od naše sposobnosti razlage dobljenega rezultata, od naših delovnih korakov je odvisen končni uspeh. Če pri tem poznamo načela razvrščanja arheoloških virov v skupine, bo možnost uspeha mnogo večja. Ob tem nam je lahko v odločilno pomoč Klejnova "Arheološka tipologija" (Klejn 1988, zlasti 335 ss). To je grm, v katerem moramo iskati.

REZULTAT – KLASIČNI IN RAČUNALNIŠKI

Obdelava grobišča Sedlo brez pomoči računalnika je pokazala, da gre za pokope štirih pokolenj in začetek petega. Računalniško razvrščanje deli gradivo na večje število skupin zaradi pripadnosti različnima spoloma, različnemu času, nakazujejo pa se tudi skupine, pri katerih je vzrok nekaj tretjega, kar zaradi majhnosti vzorca ni določljivo. Pri časovni delitvi gradiva torej nismo naredili s pomočjo računalnika nobenih novih spoznanj. Pomagal pa nam je pri iskanju nadaljnjih skupin, ki bi jih lahko podrobneje določili le pri večjem obsegu gradiva. Velike količine (npr. nekaj tisoč grobov ali predmetov) samo "ročno" niso več obvladljive. Program, ki gradivo hitro razvrsti v skupine, postane neobhoden, mi pa od njega odvisni. Če ga želimo koristno uporabiti, moramo vedeti, kako deluje, kaj naredi.

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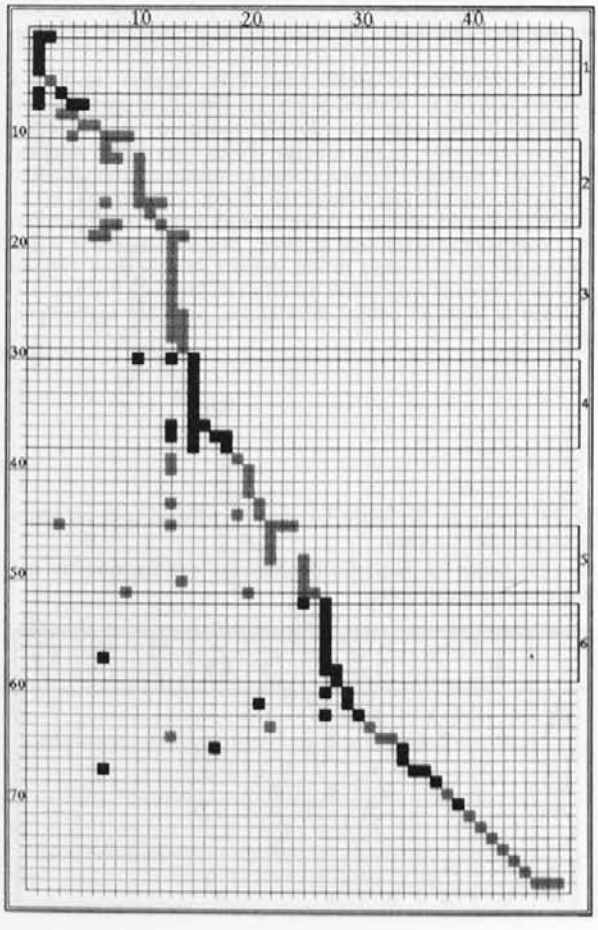

Sl. 30. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 30: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–16	13–28	25–14	37–10
2–26	14–40	26–17	38–19
3–27	15–29	27–03	39–20
4–12	16–36	28–01	40–21
5–24	17–30	29–23	41–37
6–41	18–31	30–25	42–42
7–05	19–38	31–18	43–43
8–07	20–13	32–34	44–44
9–11	21–39	33–35	45–45
10–04	22–15	34–22	46–46
11–02	23–32	35–08	47–47
12–06	24–33	36–09	48–48
1–102	20–144	39–003	58–088
2–067	21–072	40–074	59–136
3–094	22–032	41–020	60–031
4–049	23–012	42–037	61–168
5–086	24–041	43–007	62–027
6–097	25–159	44–060/019	63–004
7–015	26–147	45–085	64–166
8–137	27–036	46–054	65–076
9–024	28–082	47–048	66–055
10–090	29–006	48–053	67–146
11–022	30–065	49–028	68–058
12–043	31–149	50–044	69–170
13–101	32–152	51–056	70–040
14–087	33–059	52–025	71–096
15–005	34–155	53–011	72–033
16–089	35–165	54–163	73–154
17–023	36–164	55–062	74–002
18–091	37–077	56–010	75–081
19–009	38–093	57–013	76–029
77–143			

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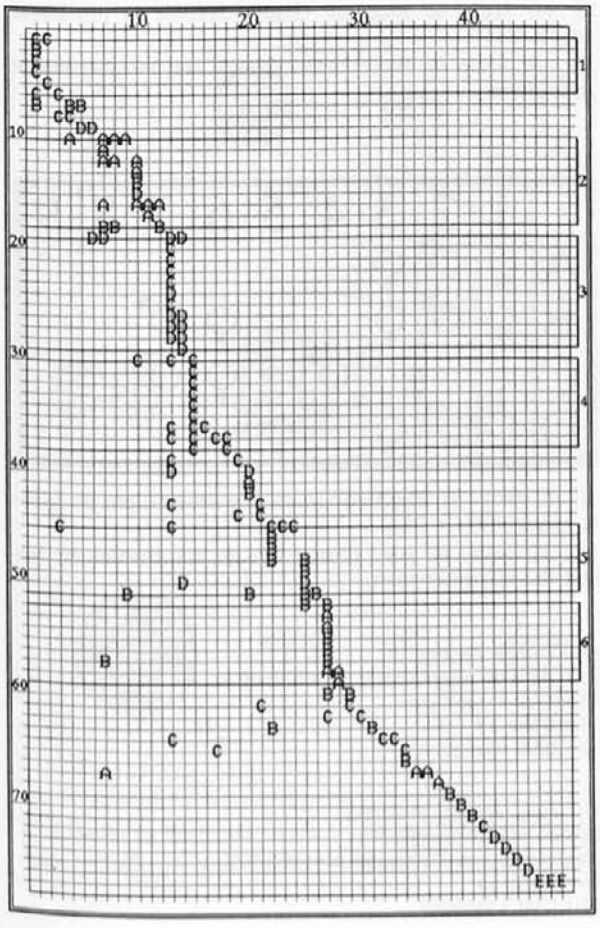
Sl. 31. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

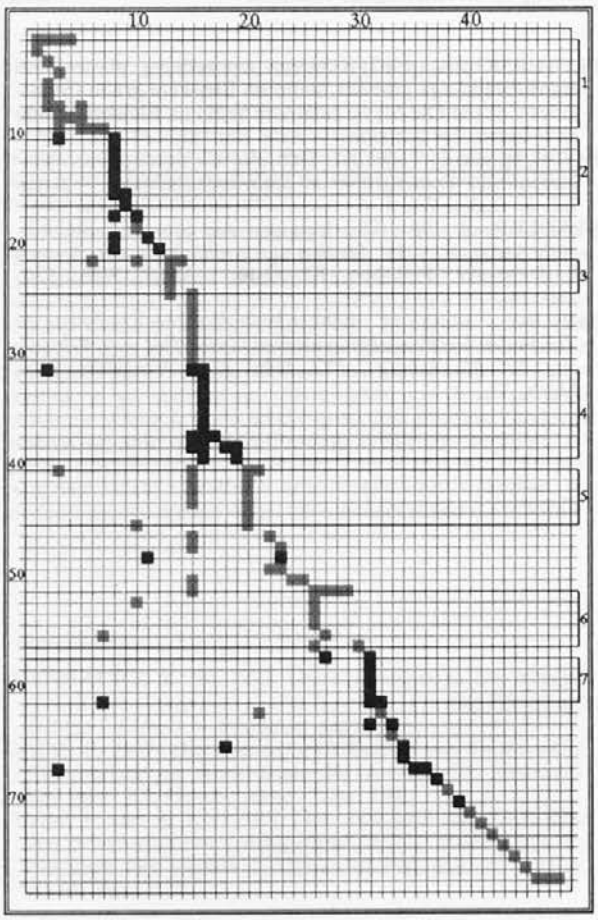
Fig. 31: Sedlo on Bled Castle. Groups and membership of generations.



Sl. 32. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 32: Sedlo on Bled Castle. Groups construction by sex and chronological order.

	1	2	3	4	5	6	7	8	9
A		♀				♂			
B	♂	♀			♀	♂			
C	♂		♀	♂	♀				
D		♀	♀		♀				

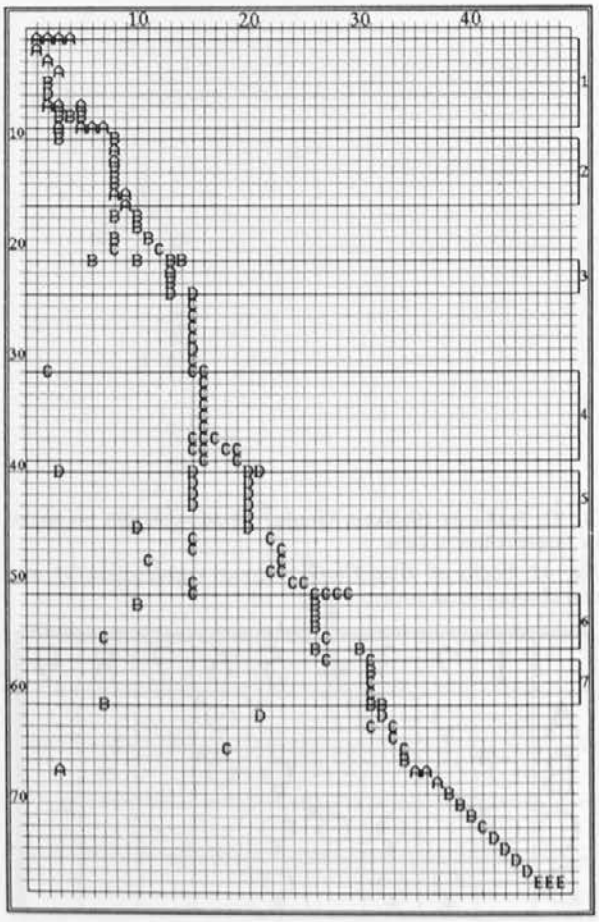


Sl. 33. Sedlo na Blejskem Gradu. Skupine in spol nosilcev. Šifre lastnosti in nosilcev po zaporednih mestih uvrstitve.

Fig. 33: Sedlo on Bled Castle. Groups and sex of carriers. The numbers of the attributes and carriers are equal to the sequence of seriation.

1–02	13–13	25–35	37–10
2–04	14–17	26–15	38–19
3–05	15–28	27–27	39–20
4–06	16–29	28–32	40–21
5–07	17–36	29–33	41–37
6–11	18–30	30–18	42–42
7–12	19–31	31–16	43–43
8–03	20–40	32–24	44–44
9–01	21–41	33–26	45–45
10–14	22–38	34–22	46–46
11–23	23–39	35–08	47–47
12–25	24–34	36–09	48–48

1–089	20–027	39–093	58–067
2–023	21–056	40–009	59–094
3–101	22–020	41–147	60–049
4–022	23–037	42–036	61–015
5–087	24–074	43–082	62–024
6–005	25–144	44–006	63–102
7–043	26–072	45–044	64–086
8–091	27–032	46–003	65–076
9–090	28–012	47–007	66–055
10–013	29–041	48–168	67–146
11–011	30–159	49–060/019	68–058
12–163	31–065	50–166	69–170
13–062	32–149	51–085	70–040
14–010	33–152	52–053	71–096
15–088	34–059	53–054	72–033
16–136	35–155	54–048	73–154
17–025	36–165	55–137	74–002
18–028	37–164	56–004	75–081
19–031	38–077	57–097	76–029
77–143			



Sl. 34. Sedlo na Blejskem Gradu. Skupine in pripadnost pokolenjem.

Fig. 34: Sedlo on Bled Castle. Groups and membership of generations.

	1	2	3	4	5	6	7	8	9
A	♀	♂	♀						
B	♀	♂	♀			♀	♂		
C				♂		♀	♂		
D	♀		♀		♀				

Sl. 35. Sedlo na Blejskem Gradu. Zgradba skupin po spolu in razporeditev v času.

Fig. 35: Sedlo on Bled Castle. Groups construction by sex and chronological order.

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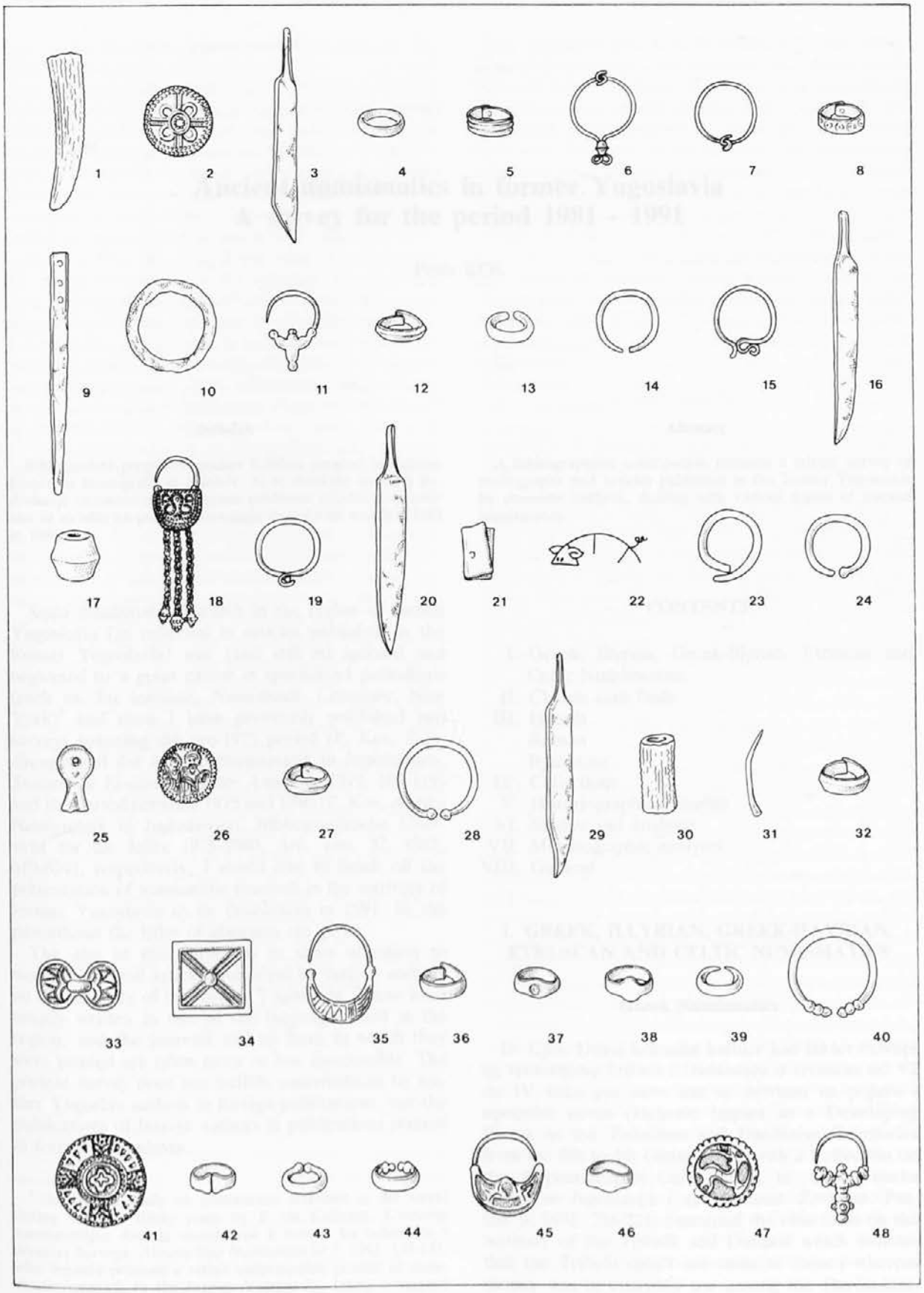

T. 1: Sedlo na Blejskem Gradu. "Lastnosti" – oblike predmetov v grobovih. Ni v merilu.
Plate 1: Sedlo on Bled Castle. "Attributes" - the artefact types in the graves. Not to scale.