# Interpreting Conflict Mortuary Behaviour: Applying Non-Linear and Traditional Quantitative Methods to Conflict Burials

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The research in this dissertation concerns methods and theories involved in the analysis and interpretation of burials related to wars and other conflict situations. Its core is a conflict interment model that I developed to facilitate the identification of material differences in burials that will help in understanding burial circumstances (e.g., whether a death occurred in direct conflict on the battlefield, as a direct consequence of battlefield injuries or other trauma, or as an execution, or was unrelated to the conflict; and whether the subsequent burial was by a 'friendly', 'neutral' or 'hostile group'). There is a great need for such a model, because exhumations tend to focus on the recovery of remains – while assuming the circumstances of death and burial – and therefore lack the structured methods and procedures that might provide additional information about what actually took place.

I analyse nine datasets from seven different conflict episodes spanning the $15^{th}$ century to the late $20^{th}$ century. The reason for using data from different centuries, types of conflict, culture, and grave type (or level of a particular type of grave) is to test the applicability of the model to: a) known grave types, in order to discern any common elements to be found in friendly, neutral, or hostile interments; and b) unknown grave types, in order to tentatively identify those responsible for interment and the circumstances surrounding the burials.

The model takes account of both normative (cross-cultural) and situational behaviours in the death and burial process, and includes variables dealing with body positioning, cause of death, presence or absence of mutilation, burial container, and ritual markers including clothing and grave goods.

The ultimate goal is to develop an approach to burials in archaeology applicable in a wide variety of recent, historic and, possibly, prehistoric contexts.

As these data have both qualitative and quantitative aspects, 'fuzzy' aspects associated with cultural attitudes to death and burial, along with situational aspects related to the conflict itself, I applied neural network analysis, a statistical approach only recently applied in archaeology. As neural network analysis is a non-linear approach, it can process both metric and non-metric data into the three main types of burials I identified in my research – friendly, neutral, and hostile – and distinguish the best variables to identify these burial types.

The results of the neural networks analysis were positive: the process yielded well-defined clusters and patterns at the intra-site level as well as at the broader, inter-site level.

These results have two main implications. First, they suggest that a conflict interment model is a potentially valuable forensic tool that may be applied in circumstances where little is known of the circumstances of death and burial outside the material evidence. Second, they show that neural networks, and other non-linear techniques, such as self-organizing mapping, may increase the range of archaeological data accessible to statistical analysis, with important ramifications for

other smaller size datasets, as they are significant in themselves as remnants of past events and clearly merit study.

This thesis therefore presents a more structured archaeological approach to qualitative and quantitative analysis of burial behaviour during conflict, by providing a means to analyse the relationship between the dead and those responsible for burial.

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TABLE OF CONTENTS

APPENDICES

## List of Tables

## LIST OF FIGURES

# Chapter 1. Introduction

## Death and Burial during Conflict

Death and burial during conflicts provoke a myriad of complex actions and emotions that often differ from behaviour in peacetime situations. Not only may causes of death be dramatically different from normal circumstances (e.g. combat related or extra-judicial) but the living may act towards the dead in ways that contrast with traditional customs, as conflicts also bring together diverse social or cultural groups with different attitudes and traditions about death. This variation in treatment is especially significant in the study of conflicts, as *who* buries the dead may not be the same as in times of peace. The difference in relationship is manifested by the material remains of the burial. What one does with those killed in conflicts depends upon whether the victims are compatriots or not, whether interment is during or after battle, and whether it is in friendly or enemy territory.

A burial by compatriots, or friendly forces, may show signs of an attempt to follow mortuary procedures consistent with the traditional culture – in other words, normative rituals. At a minimum, one would expect evidence of humane or respectful body treatment, such as conventional body positioning, and an absence of negative aspects such as mutilation or bizarre positioning. For example, the burial of a soldier by fellow prisoners-of-war in South Vietnam (circa 1968) displayed great care in the proper layout of the body even though the prisoners suffered from malnutrition and lacked the proper tools to dig a grave (Holland 2001). On the other hand, hostile forces would neither know, nor, presumably, care about individual identities to perform what is deemed traditional to the victim's culture or religion, whether or not they shared the same religious traditions. Such burials would show an absence of ritual behaviour, and in some instances, the dead might be intentionally placed in offensive positions out of disrespect, such as placing the head on the pelvis. In addition, when hostile forces commit crimes, such as extra-judicial killing – for example, the summary execution of prisoners or non-combatants – burials may be intentionally disguised.

However, the signs at a burial may not always be clear-cut; there may be a mixture of signals that can confuse the identification of burial circumstances. In the stresses of war, it might be necessary to bury the dead quickly under fire or to ward off disease, or the burying might be done by friendly forces who are of a different culture, religion or social or political group.

In order to determine the circumstances of death and burial, it is therefore important to treat the burial site as a context of cultural behaviours that produce material evidence in a spatial setting. This inclusion of context in any analysis is paramount if one is to create an accurate depiction of the conflict.

### The role of archaeology

Archaeology comes into the picture when such interments are discovered or investigated. Ideally, archaeology can apply a body of method and theory to help interpret the burial context. The archaeological excavation of burials follows a systematic methodology that is well established. For example, there is careful excavation of bones and artefacts with a thorough recording of their placement and positioning. There is also a physical anthropological study of the remains.

The problem is that traditional goals of exhumation are often part of wider studies of culture, rather than specifically focused on the circumstances of death and burial. Researchers tend to be more interested in the indicators of status and other aspects that refer to the culture of the dead, rather than to the situation of death and burial. As a result, most mortuary archaeology studies deal with normative traditions and formal burial grounds, which will have the evidence appropriate to studies of individuals in society. Unfortunately, this focus is not suitable for the study of conflict period burials, because conflicts involve tensions that cut across social and cultural boundaries and provoke actions that may be contrary to social norms.

There is an archaeological study of conflict on battlefields, or battlefield archaeology, which joins with history in concentrating on the study of battles, using a combination of historical documents and archaeological evidence. Again, this approach does not address the conflict itself, but rather the historical events. One notable exception, however, focuses on conflict behaviour and combat modelling. In the study of the archaeological remains of the Battle of Little Big Horn (1876), Fox used the distribution of material culture and testimony from surviving American Indian participants to establish that the American Indians were better armed than previously assumed and that they probably outgunned the U.S. 7th cavalry and forced them into a disorganised retreat rather than a dramatic 'last stand' (Fox 1993: 337)

In fact, most conflict burials are not excavated by archaeologists at all, but rather discovered accidentally during land redevelopment, as part of war crime investigations, or, as in the search for MIAs (soldiers missing in action) in Korea and Vietnam by the US government. In these cases, the primary intent is to determine the identity of the victim and, perhaps, the circumstances of death.

These examples suggest that there needs to be an archaeological study focused specifically on conflicts, on death and burial in the theatre of war – studying burials that are the residues of a conflict that have either been unintentionally forgotten or purposefully ignored. Such graves can be the remnants of civil conflict and extra-judicial killings, burials in the haste of battle (e.g. burial in a fox hole), or more organised, yet forgotten burials, such as those in cemeteries no longer recognisable because of decay and neglect.

## Conflict archaeology

The goal of conflict archaeology is not only to determine the death and burial circumstances of individual victims, but also the identity of the buriers by means of the material evidence at the burial site relating to cause (or manner) of death and treatment of the body. This approach offers a more detailed view of conflicts and helps in understanding questions such as the treatment of combatants (attitudes of the enemies towards each other) and, in the landscape of a battlefield, details of territorial control, and the ebb and flow of battle. It also looks beyond the actions on the battlefield to the attitudes and behaviours of social and cultural groups towards others.

The study of conflict period burials differs from more traditional examples of battlefield archaeology, which tend to concentrate on reconstructions of the actual battles and the recovery of bodies and material culture. It also takes one more step away from the majority of mortuary studies, which tend to focus on the status or rank of the deceased. To understand conflict burials, it is necessary to identify who was responsible for burial from the archaeological evidence (e.g. artefacts, body treatment) and the context of the site. Conflict archaeology therefore explores the death and burial events and their meaning and significance in the *culture of conflict*. The culture of conflict brings together combatants who are typically of different cultures or social and/or political background, and who therefore act differently towards the dead. In order to do this, it is necessary to consider not only the events of the conflict, but also the general attitudes and traditions associated with burial in the cultural groups involved. Knowledge of normative practices is necessary to identify the buriers, because the degree of variation from the norm may indicate the degree of separation from the dead.

This approach incorporates the identification of patterns in the broader theoretical framework that recognises the underlying role of the social context. Humans are social beings that react to situations outside the realm of normal, more peaceful times. Furthermore, conflict burials have the potential to provide evidence of social processes related to attitudes about death and the dead, within and outside a cultural group. Conflict causes people to act differently than they would under peacetime circumstances. Conflict therefore provokes behaviours in matters of death and burial that may reveal attitudes of the combatants about each other, and their culture. It is how these differences are manifested in burial behaviours that is the focus here.

## Analysis of Conflict Death and Burial

As mortuary behaviour is a dynamic social domain, which is made more complex during conflict situations, a series of models are developed to define the characteristics of conflict burials and these models are analysed in a series of quantitative techniques. Since variation in intent in conflict burials is so important to interpretation, what is needed is a more flexible method that allows the addition of more qualitative data and has the potential to offer a new perspective on the data.

When viewed together, qualitative and quantitative data can offer important information that can be applied to test the applicability of the model to conflict burials.

In order to identify a framework that will assist in the problem of recognising the type of conflict burial, this thesis begins with an assessment of the various theoretical approaches and methods of mortuary studies. Chapter 2 examines these studies in order to refine an approach within the methodological and theoretical context of other similar anthropological and archaeological research. They are discussed and evaluated on how they can contribute to the study and understanding of conflict burials.

Following this discussion, a model is developed in order to interpret what characteristics to look for in the distinction of normative and anomalous burial types encountered in conflict areas. It identifies characteristics of anomalous sites and behaviours at burial sites within conflict areas and yields possible explanations for those deviations from normative practice. The refined theoretical framework and model are applied to a series of archaeological and non-archaeological data, which include the retrieval of remains from conflict zones for identification or for evidence in criminal proceedings. To test the applicability of the model over time, space, and culture, it is tested through the analysis of war dead over five centuries in six countries.

The dataset consists of 434 cases, including conflict and normative cases, ranging from a medieval England mass grave (1461) to more recent graves (1995). The sites represent a variety of times and cultures: English medieval, two sites from the American Civil War, American War of 1812, one individual North American battle (Battle of Little Big Horn), four burials from the Spanish Civil War, several graves from the Korean War, and the conflict in the Former Yugoslavia. This eclectic mixture of cultures and periods is another example of the unusual facets of this study. As the goals of the exhumations differed, so did the quality; therefore the overall sample size is small. However, these smaller sized samples do exist and it is necessary to develop a methodology that can be applied to smaller datasets because there is a wealth of information that they offer.

The methods of analysing these data are a mixture of traditional multivariate methods and the more novel approach of neural networks (in this study, the Self-Organizing Map or SOM method) in order to identify the quantitative approach that best distinguishes different conflict burial types. The multivariate techniques are used to explore the data for potential patterns as well as correlations among variables in conflict mortuary behaviour.

There are four stages of testing using multivariate techniques. The purpose of the statistical testing is two-fold: data reduction and classification. The initial testing phase, using factor analysis, reduces the number of variables and the latter three phases of testing are concerned with classification of the data based on the three conflict burial types.

Following this step is an examination of the clustering results and correlations identified by the neural network method. The SOM, which is relatively new in archaeology, is also a tool used for data exploration, or data mining. It has an advantage over traditional multivariate techniques in that it can accommodate non-linear data such as descriptive locational data or cause of death variables. For this reason, the application of the SOM seemed appropriate as an analytical method because it emulates the variability in mortuary behaviour, which under conflict situations varies with circumstances of time, place, culture, and event.

The reason for the use in this analysis of the traditional multivariate techniques in conjunction with the more novel approach of neural networks is to develop a comprehensive method that incorporates both quantitative and qualitative data and is capable of recognizing patterns in conflict mortuary behaviour. Associated with an interest in the social patterning present in burial data are the quantitative methods that are utilized in an attempt to extract them. The use of certain quantitative methods provides certain advantages, such as identifying correlations among variables. The use of the SOM approach can be seen to have two major goals. Firstly, analysis of the structure of the data may reveal some completely new features of the behaviours considered. Secondly, it can also indicate patterns and weaknesses in the variables.

The approach to the analysis and interpretation of burial remains emerges from a theoretical framework as well as observations of the archaeological data. This thesis proposes a data analysis methodology that works within a theoretical framework that encompasses the context of the site as well as the material evidence.

To reiterate, the following analysis does not focus on the social dimensions of the dead as they are represented in burials. This study of mortuary behaviour in a conflict situation requires the exploration of a context dramatically altered from the social norm, one in which the context of living and dying varies according to the conflict situation, along with patterns of behaviour. This research will explore how burial can reveal some of the more theoretically orientated aspects of conflict and the respective individuals, social groups and cultures involved and their interaction when they are examined in a qualitative and quantitative manner. This examination of shared characteristics and comparison of differences between sites may reveal patterns of cultural behaviour that can ultimately assist us in gaining insights into the nature and circumstances of conflicts themselves.

# Chapter 2 Theoretical Framework for the Analysis of Conflict Period Burials

## 2.1 Introduction

There is a wealth of information from diverse sources relating to the study of normative historical and contemporary mortuary behaviour, with a variety of opinions and paradigms as to the most effective method of analysis. Since there is so much variation in approaches, methods and theories, archaeologists continue to search for new ways to study mortuary behaviour that better incorporate meaning, as reflected in the forms of human expression evident in ritual practice, belief systems, and customs (Whaley 1981: 4).

Mortuary practices may be "the result of actions which contribute to shaping society itself" (Härke 1997a: 21) and therefore signify broad cultural patterns beyond specific societal and cultural boundaries. The treatment of the dead and subsequent burial practices can also shape or influence social values, or reflect the society, and may actually influence the way a society views life and death. This is shown clearly by the profound influence of the Holocaust in Jewish culture and by attitudes to social groups within and among warring cultures, based on the treatment of the dead by combatants and other participants.

There is more to a burial than the extent to which ritual behaviour was performed. Ian Morris states that one of the failings of previous studies of mortuary behaviour and ritual was that it was approached by assuming that "ritual can only be analysed as part of religious belief, and that this in turn has little to do with 'external' phenomena such as power, conflict, class, ideology, and so on" (Morris 1992: 2). However, the 'external' phenomena commented upon by Morris have a direct impact on the nature of rituals and to what degree those rituals are performed in the disposal of the dead. For example, while there may be an attempt to maintain some semblance of normative ritual behaviour, in the case of conflict and where areas are under dispute and the numbers of dead are greater than normal, some aspects of the normative ritual may not be followed. While a group might intend to abide by religious belief, they may simply not be able to follow through. Religion is therefore only one part of the ritual. Class, ideology, and conflict may limit the extent to which funeral rites are carried out; therefore, ritual cannot be separated and analysed in isolation.

Death rituals are a socially constructed event. The fears, hopes, and attitudes people have towards it are not instinctive, but rather are learned from such public structures as the languages, arts, and religious and funerary rituals of their culture. It is assumed here that any broad-scale change in the relationships between the living is accompanied by modifications of these death meanings and ceremonies, as Huntington and Metcalf note:

> Cultural difference works on the universal human emotional material, just as it does on universal modes of reasoning or requirements of institutional arrangement. Although we clearly recognize emotions that are familiar to us, the range of acceptable emotions and the precise constellation of sentiments appropriate to the situation of death are tied up with the unique institutions and concepts of each society.
>
> Uniformity of human emotion does not explain the rituals of societies. The baffling combination of the familiar and the strange, the universal in the cultural particular, confronts the anthropologist even when examining human sentiments, even human reactions to death (1979: 43).

The conflict period burial model to be outlined and discussed below is therefore more than just the study of remains and artefacts within the context of a site. It takes into account the variability of these behaviours across cultures in order to provide a socio-cultural context within which to interpret death and disposal of individuals during conflict periods.

## 2.2 Theoretical Approaches to Mortuary Studies: The Study of the Burial Context and Mortuary Theory

In order to understand the nature of death and burial in a specific culture, it is first necessary to consider the theoretical background and methodology used by individual researchers, as each approach will select, analyse, and interpret data within specific cultural and historical paradigms.

### 2.2.1 Functionalist Approach

Many previous studies of mortuary behaviour have focused on the role of grave goods and other ritual markers at the individual level to suggest social status. It is the relationship between the individual and the degree of the funerary commemoration that is central to these studies (Binford 1971; Tainter 1978).

Many theses on mortuary behaviour have discussed and analysed the role of status of an individual and how that is reflected in the archaeological record. The deceased is viewed in a specific way in a social context, and this is subsequently represented in burial. Saxe (1970) discusses an individual's 'social identity' and the interaction of the individual with others according to the rules of the larger social milieu and how this 'social identity' is personified, manifested, and perpetuated in burial.

A majority of the earlier works in mortuary studies focus on status and/or rank, the identification of vertical divisions. For example, Saxe (1970) defined eight hypotheses regarding mortuary practices to identify or define social identity and rank among a community. He proposed that burial types should be viewed as expressions of the individual's social identity. Saxe was looking for evidence of structure through burial data and asking whether selectivity for one sex over the other is evident in the composition of the burial. The often-quoted 'Hypothesis 8' of Saxe states that:

> To the degree that corporate group rights to use and/or control crucial but restricted resources are attained and/or legitimized by means of lineal descent from the dead (i.e. lineal ties to ancestors), such groups will maintain formal disposal areas for the exclusive disposal of the dead, and conversely (Saxe 1970: 119).

There are two important limitations to be considered here: 1) any clustering that may be perceived does not necessarily represent descent groups, but merely the presence of some form of division; and 2) this does not apply to non-normative circumstances where the rules of behaviour have changed.

Binford expanded on this approach with his study of Inuit burials. Binford also suggested that mortuary behaviour was independent of everyday life, but linked to social organisation (1971: 6-29). Binford broke down the components of burial to the following 'dimensional distinctions':

1. Treatment of the body itself: articulation, disposition of burial; number of bodies in grave, mutilation;
2. Preparation of the disposal facility: type of burial; orientation, location of facility;
3. Burial context within grave: arrangement, grave goods; and
4. Population profile and biological dimensions: age, sex, disease, and relationships (Binford 1971: 19).

He then applied tests of significance to age, sex, location, and social position to test his hypotheses. He also used frequency tests to analyse his proposed dimensions of the social persona represented in mortuary behaviour. Binford concluded that social complexity will determine the number of dimensions of the social persona will be symbolised in burial (Binford 1971: 23); however, this assertion is difficult to demonstrate cross-culturally, with complexity being entirely subjective.

The Saxe/Binford approach focused on developing cross-cultural rules. However, it relies on the assumption that a single attitude to death and burial applies and different responses and attitudes are not considered, thus limiting the scope of the approach.

Tainter expanded on this approach of cross-cultural rules to mortuary analysis by arguing that it is possible to develop indicators of individual status from mortuary contexts (Tainter 1975: 2). Tainter introduces one way to identify an individual's rank – through the study of 'energy expenditure' and how it would affect grave size, bodily treatments, and grave ornaments (1975: 2). While he uses the concept of 'energy expenditure' to interpret prehistoric burials, it is applicable to areas in which there is ethnographic or documentary data to supplement the archaeological interpretation. This concept of energy spent on an individual's grave can also suggest something of the attitude of those conducting the burial, as the treatment will be different according to the nature of their relationship to the deceased. This approach is clearly problematic in the study of mass graves, as a person's status may not be clearly defined. Furthermore, Parker Pearson's study of British mortuary practices in the late 20th century, focusing on the Cambridge area, identified a clear contradiction to Tainter's model. Parker Pearson's assessment indicated that the gypsy community had the highest expenditure and most elaborate funeral and markers, yet this group are generally recognised as being members of the lower levels of British society (Parker Pearson 1982: 104).

The functionalist perspective does not address the role of, and changes in, ritual behaviour and its indirect impact on the artefacts that do appear. Nor does this approach analyse the horizontal dimension of kin groups, clans, or religious membership. Furthermore, it cannot account for changes in the meaning of artefacts when they are used in different contexts (Hodder 1982b: 152) because meaning is not locked into one period of time or place. Humphreys observed that:

> ...the conceptual barrier is based on the antithesis between 'things' and the meaning people attach to them. ...Social anthropologists produce examples of burial forms or artefact patterns of which the archaeologist would never guess the meaning without help from ethnographic or written sources; and it is attractive to some archaeologists, in response, to look for a solution in stressing the materiality of their data, in associating themselves with 'science' rather than with history, in seeking ways of making the facts speak for themselves (Humphreys 1983: 172).

Consequently, there has been a move towards a study of context and of 'patterned similarities and differences in relation to the object and the questions being asked' (Hodder 1987: 6). While addressing the importance of context in studying mortuary behaviour is not a new idea (Hodder 1982b; 1986; Shanks and Tilley 1987), it is often a neglected one. The complexity of a given society or its structure as a whole is not the focus in this research, but how the society of the buriers responds to death in a conflict situation.

### 2.2.2 Post-processual Approaches

The fundamental inadequacy with the functionalist approach towards mortuary behaviour is that it does not address the role of human decision and independent behaviour. Humans are more than just instruments that fulfil some function or role; they possess emotions that go beyond function and reason. Because individuals act emotionally, they do not always act in their best interest; therefore, they tend to violate the tenets of the functionalist perspective (Hodder 1982a: 5).

Archaeologists (such as Chapman and Randsborg 1981; O'Shea 1981; and Pader 1982) have integrated the concepts of agency, structure, and practice in mortuary analysis, drawing on Giddens (1979; 1984) and Bourdieu (1977). This theoretical framework outlines some central themes in mortuary research, such as the presence of grave goods and other ritual markers as asserting the identities of the deceased. The elements of structuration and agency work on the premise, in this area of study, that the remains of mortuary behaviour are intentional signs, not arbitrary events. However, the complex features of mortuary behaviour should not be, and are not, symbolised by a limited focus of the entire social system at the expense of the individual and individual actions. Most importantly in the study of mortuary behaviour it is necessary to recognise the context and the meaning of actions and symbols within the confines of that context (Hodder 1987: 1). This is critical in analysing conflict burial behaviour because burials under these conditions do not follow normal social patterns; consequently, not only can they deviate from the norm, but they can also be manipulated and altered.

Hodder emphasised this element of intent and powerful symbolism in the example of symbols associated with royalty being used on a beer label to increase sales (1982a: 9). It illustrated how some analyses examine abstract codes where meaning is merely seen as arbitrary. The importance of this approach to symbolism in the study of mortuary behaviour is especially relevant here, as the attitude of an individual or group towards the dead might influence burial circumstances – such as the placement of an 'enemy' corpse in an inappropriate or offensive body position as a symbol of this status.

While status may be an important factor in the analysis and interpretation of a grave, it is not the only aspect that needs to be addressed. As Humphreys commented:

> The fact that archaeologists tend to pay particular attention to signs of social stratification or ranking in their attempts to deduce social status from grave-goods or from the forms of tombs and monuments (sex, age and other criteria of status differentiation have been less thoroughly researched and are often integrated into models of social stratification) no doubt reflects the preoccupations of modern society (1983: 173).

Current mortuary analysis does not revolve around status and rank alone or the changes in a culture. Some studies examine the influence of gender and other social elements on mortuary practices (e.g. Huggett 1992). Much is made about the vertical dimension represented in mortuary remains, but there has been only limited work on the horizontal dimension, such as kin groups, secret societies, or post-marital residence (e.g. O'Shea 1981; 1984). However, this dimension can be even more difficult to identify than vertical differences as O'Shea notes:

> ... horizontal distinctions should be expressed through channels of 'neutral' value. Hence, 'unvaluable' tokens such as clothing, coiffure, symbolically distinctive artefacts, and elements of body posture and orientation, should be common indicators of horizontal differences. Unfortunately, such symbolic indicators are most likely either to be unpreserved or to be ambiguous to the archaeologist (1981: 49-50).

Not only can this form of differentiation be difficult to observe, these distinctions may even be masked in conflict burials. One can examine the ethnic, gender (not merely biological sex), and age make-up of the burial, but the traditional vertical dimension can be absent from a conflict burial. Additionally, the horizontal groups take on a new meaning under these new circumstances. In the case of conflict burials, the cause of death or political affiliation can be the basis for a different type of horizontal group. Deviations in mortuary practices may indicate sudden changes in the culture or the region, such as widespread disease, war, or natural disaster.

Mortuary behaviour has been analysed as part of cultural, symbolic, and individual action and the context in which these actions occur. Hodder states that:

> ...all social strategies and adaptation must be understood as part of cultural, symbolically meaningful contents. For example, burial[s]...are not simply behavioural reflections of adaptive strategies, functioning to allow information and energy flows. They are culturally and symbolically formed as part of, respectively, concepts of death (1982a: *viii*).

Subsequently, burials can also offer an insight to differences between cultures and intents according to how different cultural groups bury the dead of a different culture. As suggested above, this 'meaningful and expressive' reaction to death (Huntington and Metcalf 1979: 1) does not automatically indicate that such burials would follow the rites and social mores of the culture of the individual(s) being buried; this reaction could indicate antipathy rather than reverence.

Furthermore, different rituals may have the same meaning, or similar rituals may have different underlying beliefs. Mortuary behaviour is not a static entity; it has a tendency to change in different situations (Ucko 1969: 263). Humphreys reiterated this supposition with the prospect that "death provides occasions and material for a symbolic discourse on life – through the different treatments accorded to those whose lives have ended in different ways" (1981: 9). While she may have been referring to burials under normative conditions, this is appropriate to the conflict situation, because the change in treatments may be evident as well as the patterns of day-to-day behaviour.

In addition to the patterning of artefacts and skeletal attributes, the spatial patterns that emerge at the cemetery or regional level need to be explored (Chapman and Randsborg 1981: 14). As Owsley (1997) notes, the location of the burial in relation to others in the area, body orientation, body treatments, grave ornaments, and the spatial patterning of these attributes may suggest an individual's status, religious and cultural affiliation, and also the contextual aspects in which the burial occurred (Owsley 1997: 2) – unless a burial has been ritually disguised to obscure social status, as Parker Pearson discusses in his analysis of patterns in mortuary practices (1982: 101). Such differences in mortuary behaviour can be patterned through time, location, culture, or attributes (artefacts and skeletal treatments) (O'Shea 1984: 21). These varying patterns may suggest changes at the social level as well as changes in the treatment of individuals, as all burials preserve actions and attitudes related to the perception of individuals in society.

The study of mortuary behaviour therefore goes beyond the functionalist approach where the burial performs the function of merely disposing of the body. There is meaning in how the burial is done, whether that meaning derives from religion, status, or ideology. Artefacts, or their absence, symbolise the roles and the adherence to the rules that are part of religious, cultural, or ideological practices. The remnants of these symbols allow us to reconstruct patterns of behaviour at the site of burial. Härke, however, reminds us that "...there can be no doubt that burial ritual is shaped by thoughts, concepts, ideas and intentions, which make seemingly 'straightforward' inferences from burial evidence dangerous, or even impossible" (1997a: 24). Indeed, the dearth or absence of grave goods may indicate intentional behaviour rather than an oversight: an individual may not have deserved, for one reason or another (e.g. manner of death, poverty, deviant behaviour), a conventional burial with all the rituals. Body treatment variables, particularly significant in the analysis of conflict period burials, show that there is more to mortuary behaviour than ritual markers expressed in material culture. Cannon comments on how the differences in the extents to which the remnants of mortuary behaviour have been perceived:

> Interpretations of synchronic and diachronic variation in mortuary behaviour typically adopt the premise that the intensity of expression is a direct measure of the basis of expression - that a more intense mortuary response reflects either a greater social loss, proportional to the status and social roles of the decease and family, or a greater emotional loss and degree of person sentiment and religious piety (Cannon 1989: 446).

As noted above, there is also a body of work that suggests that a person's status may not be directly reflected in mortuary remains. The study of burials as reflections of the social status and rank of the deceased has been challenged by approaches that treat burials as masking, and not reflecting social status (Parker Pearson 1982: 101).

Furthermore, the formal properties, the frequency, and the patterning of the distribution of artefacts may indicate the meaning and importance of the artefacts to mortuary behaviour (O'Shea 1984: 43).

> It is clear that one must look beyond grave associations to understand the structure of a mortuary site and the society which produced it. The archaeologist now knows that the treatment of the body, preparation of the disposal facility, burial context within the grave, and the population profile and biological dimensions must all be examined. In other words, the mortuary system is a multidimensional system (Goldstein 1981: 57).

As this thesis shows, an important aspect of the multidimensionality of burials is that during periods of conflict, the analysis of burials can offer information relating to differences in the treatment of the dead across cultures and reveal evidence of animosity and other inter-cultural attitudes when members of one culture bury the dead/victims of another culture. It is important to reiterate that burials are a component of behaviours under fluid circumstances, and this is even more apparent and appropriate under conflict conditions.

### 2.2.3 Goals of Mortuary Studies

Shepherd, in her concluding remarks on the archaeological study of mortuary behaviour stated that:

> ... burial is only one small aspect of funerary behaviour and that the formers' manifestation if fully dependent on the larger ideological contexts present in the society. Funerary behaviour cannot be understood without due consideration of ideological aspects. Without ideology, one is left only with an explication, devoid of meaning, of the range of mortuary variability (1999: 16).

This may be true in normative contexts, but when it comes to an aberrant situation, instinct may take over and all cultural and ideological pretences may be forgotten, discarded, or dismissed. This behaviour is not 'devoid of meaning' as Shepherd suggests, but the apparent lack of ideology is, in itself, quite meaningful, while O'Shea confines "burial to a single, brief event" (1984: 38).

"Mortuary theory in archaeology seeks to understand and decode the rituals and symbolism associated with the disposal of the human body after death" (Harrington and Blakely 1997: 113). However, mortuary theory should not be limited by the study of the symbolism and rituals involved in burials, but should also include an understanding of the events that surround the burial (such as the attitude of those conducting the burial towards the deceased), and contextual or situational constraints (including the time available for planning and completing the burial). These additional factors are most relevant in determining the mode of burial in a conflict period setting.

O'Shea believes that "there are limitations inherent in the archaeologist's ability to discriminate and explain the mortuary patterning which is present" (1981: 40). This idea is even more valid when considering the context of conflict burials in which a mass grave is used and no one knows who buried the dead.

## 2.3 Theoretical Framework Applied to Conflict Burials

### 2.3.1 Burial Rituals – Problems of Analysis

While many previous studies of mortuary behaviour have included extensive sections on the role of ritual and other patterns of normative ritual behaviour, the situations examined in this study are quite different; they do not represent the burials of one culture, one period of time, or normative conditions. As such, the role of ritual is reduced in not only the study of these burials, but in the burials themselves. These are burials under extraordinary circumstances. It is therefore necessary to go beyond "the purely *formal* study of mortuary practices and look at the *processes* that might have given rise to these forms" (Chapman 1981: 72; emphasis Chapman). This is not to deny the role of ritual behaviour in conflict burials, because indeed, it can be the absence of ritual behaviour that suggests aberrant behaviour.

Given the emotive nature and other difficulties surrounding the archaeology of warfare, the identification of a burial as either by friendly groups or hostile groups is difficult with the current techniques and methodologies employed in archaeology and without the added dimension of documentary evidence and/or eyewitness accounts. However, by analysing the material evidence, and comparing what is known to be present in the normative with what might be expected in a non-normative burial, it is possible to reveal the circumstances surrounding the death and burial and the attitudes that prevailed.

Until recently, the study of conflict archaeology was quite limited. Interest in battlefield archaeology has, however, exploded in the last decade (e.g. Carmen 2002, 1999a, 1999b, 1997a, 1997b; Dore 2001; Freeman and Pollard 2001; Wood 1994). Yet, this increased awareness is still constrained by the archaeological record. According to Vencl:

> ...difficulties in explaining the archaeological remains of warfare are an objective expression of the fact that 1) some important features do not form archaeological contexts because of their nonmaterial character or because of their perishable nature, or alternatively, for insufficient concentration and burial. Archaeology is further characterized by 2) a limited capacity to distinguish phenomena

> following one after another in a short interval of time (Vencl 1984: 121-122).

So not only is the archaeological record lacking the non-material features of conflict an issue in studying conflict archaeology, but also "the relationship between society and burial practices has to be understood as the relations between living and dead before making social inferences" (Parker Pearson 1982: 110). Parker Pearson states further that: "mortuary practices and the relations between living and dead, has been developed as a potential medium for the ideological manipulation of power amongst the living" (Parker Pearson 1984: 69). The challenge of conflict archaeology is therefore to find a way to identify variations in treatment of burials that may reveal details of the attitudes and behaviours involved in this fundamental relationship.

Therefore, such an archaeology is problematic. Since wars and other conflicts are partly motivated by ideology and politics, the actual situation is rarely clear and access to information is difficult. Yet, the buried symbolise what those responsible for burial deemed appropriate, as Huggett observes quite succinctly:

> The social identity of an individual as represented in their burial is therefore dependent upon the way that other people chose to represent the nature of the person in death. Assumptions concerning the social position of the deceased are in fact based upon the relationship of the buriers with the buried – on what they chose to represent in the burial (Huggett 1992: 81).

In conflicts, such choices provide the crucial evidence that allows one to determine whether this relationship was positive or negative – with ramifications that might shed light on the circumstances of the death as well.

### 2.3.2 The Archaeology of Conflicts

The term 'Conflict Archaeology' is used in this thesis rather than 'Forensic Archaeology', which most commonly refers to the modern exhumation and study of buried bodies, or forensic anthropology which applies physical anthropological methods in a forensic setting. Conflict archaeology incorporates current archaeological theories and methods because the behaviours and many of the motivations in a conflict atmosphere not only apply to recent conflict periods, but also to historic, and most likely, prehistoric conflicts. This approach examines both material and cultural aspects, as the behavioural context of a conflict burial may relate to common instinctual behaviour and practical necessity as well as to the beliefs and practices of a cultural group because the behaviours of living during conflict, or conflict culture, can be very different from peacetime. The determination of whether a particular grave created during a specific conflict period is friendly or hostile depends on the circumstances of death and burial as they are manifested in the physical context of the grave. This approach uses characteristics of normative burial practices for the warring cultural group or groups as a standard for comparison with what is excavated.

In a general anthropological context, conflict archaeology can be used as a means of helping to understand the complexities of war. Since war is commonly motivated by ideology, economics, and politics, analysis and interpretation are difficult because historical documents reflect the ideas and biases of their authors. Conflict archaeology provides a means of testing and verifying what is discussed in documentation and testimonies, and therefore is a powerful means of getting closer to events and behaviour. At a more specific level, the analysis of burial behaviour at different locations in a specific theatre of conflict may reveal details of territorial occupation and movement, and the comparison of such behaviour in different conflicts over time may provide information about the nature of the conflicts, even if other documentation is lacking.

## 2.4 Development of a Conflict Period Burial Model

Humans bury their dead within a dynamic context, which includes societal, temporal, and emotional factors; consequently, these factors will influence where, why, and how others bury and respond to the death and disposal of an individual. As noted above, the treatment of the dead during conflict may vary significantly with the conventional behaviours associated with mortuary customs. War deaths are often not treated as conventional deaths. The dead are not just any dead, to be commemorated as other dead were commemorated - new responses are demanded (Tarlow 1999: 154).

The model outlined below is intended to explore the treatment of war dead across time, space, and culture by identifying characteristics of anomalous sites/behaviours at burial sites within conflict areas and suggesting possible explanations for those deviations from normative practice. The model offers an outline of what characteristics to look for and examine during the excavation process and a foundation to develop further models for anomalous burial types that are encountered in archaeology.

As noted above, this contextual approach is necessary because a burial needs to be analysed in a way that incorporates social relationships in the wider society, including non-burial rituals (Parker Pearson 1984). Such relationships may be manifested in extreme ways during conflicts, depending on whether the living and the dead are from the same or opposing groups. The contextual perspective incorporates in its approach the environment (social and physical), and an object's meaning and function within these forms of environment (Hodder 1987: 1).

The model presented below addresses the following aspects surrounding the excavation and subsequent analysis of mass graves from conflict periods: conflict type; cultural affiliation of victims and perpetrators; grave type; the presence or absence of selectivity based on status, sex, or age; the sequence of events preceding and following burial (time); and any patterns that may emerge from any of these and other variables addressed. Within the model, there is a classification system for anomalous grave types resulting from variations in behaviour during burial. These anomalous grave types record differences from the normative pattern of the region or culture by the presence of aberrant forms of location, construction, and content. The three general departures from normative grave types are: *friendly, neutral,* and *hostile* burials. Friendly burials are graves most likely constructed by compatriots, friends, or family; neutral burials are those done by individuals without any particular emotional or political ties to the deceased; and hostile burials are those constructed by individuals with a religious, political, or ideological antipathy towards the dead. The ability of the model to discern anomalous grave types and behaviour is of course contingent upon evidence related to the normative burial practices of a region, culture or social and/or political group, as recorded in documents and mortuary studies.

Normative and friendly burials follow social prescriptions; neutral and hostile burials do not necessarily follow the same rules. In the absence of ritual, the aim of both of these latter types of burials is to get people in the ground as fast as possible. However, the motivations may vary greatly. In an expedient burial by friendly groups, those responsible for interment may attempt to bury their fellow countrymen and/or compatriots in a manner consistent with normative tradition out of concern for the dead, but time constraints may limit the extent to which they can follow the prescribed rituals. In neutral or hostile burials, on the contrary, whether clandestine or simply a burial during hostilities, the remains may be treated with little regard to the deceased. Therefore, identifying the type of burial, friendly, neutral, or hostile, needs to be approached in a systematic and structured manner using a model of expected characteristics.

### 2.4.1 Variables Defining Burial Type

The following are general descriptions of the variables used to define conflict period burials (see Table 2.5 for complete listing of burial types and corresponding attributes). Some variables reflect an individual's identity, such as gender, status, and age and others relate to the treatment of the body. Evidence of intent on the part of the buriers may be evident in the manner in which a body is buried, so the discussion below considers, for each variable, its potential as an indication that the burial situation was friendly, indifferent (neutral) or hostile.

As some variation in mortuary behaviour may be the result of other social traumas, such as disease, famine, and poverty, these variables are detailed enough to cover the most common aspects of death and burial in conflict situations.

#### 2.4.1.1 Grave variables

For the purposes of this research, 'grave' or 'burial' is meant as the inhumation of an individual, group or a mass of individuals in the ground, or in a mound, with or without a coffin or ritual grave ornaments. Burial may consist of single (i.e. primary) or multiple periods of interment. Whether or not the method of burial is in accordance with legal or religious rites, the artefacts present are the remnants of the behaviour associated with disposal. There are times when the "attitude to burial simply as a means of disposal, even when specially designated burial area exists, is not uncommon ethnographically" (Ucko 1969: 264).

Burials may take place in a formal or informal cemetery or burial ground or they may be placed randomly as a matter of expedience. These burials fall under the 'cemetery type' variable. Burials may also be intentionally obscured, often to hide evidence of mass execution.

Cemetery type (Grave location)

The 'cemetery type' variable has two options: normative or non-normative. Rugg discusses some of the attributes assigned to cemeteries, which include location (close to or within a settlement), boundaries, roads and/or paths, and the context in which one memorialises the deceased (Rugg 2000: 261-262). The separation of German soldiers from Allied soldiers from World War II demonstrates how those responsible for burial represent political, ethnic, and ideological differences even in death (Tarlow 1999: 157) and how patterns can develop based on religion or class.

In a conflict, a cemetery used by a friendly group may be expected to follow a normative pattern where possible. A conflict cemetery may be located next to a church or on the outskirts of a settlement, or where necessity dictates, as in burial at the scene of the death or behind defensive lines. Burial on the battlefield may also be an intentional act to mark the place of battle and serve as a memorial to the dead. One would expect some form of grave marker to be present.

The graves expected for a conflict period burial may deviate from the norm in some respects if casualties are high and the time allotted for the task of burial is short; nonetheless, it may be expected that some normative features will be retained. If burials are isolated or in small groups, and the individuals have been interred in an expedient way, analysis of a grave and its contents will be necessary to determine whether or not it has normative features.

A burial performed by a neutral group is likely to deviate from the normative location, because of indifference or lack of knowledge of burial traditions. The grave may be located where the mass of bodies was placed after removal from the battlefield, or on the battlefield itself. It may or may not be marked in some way. It is expected that a hostile group will use unmarked mass graves, either pits or trenches, for the burial of casualties, as they will be antagonistic or indifferent to appropriate burial rituals or treatments; however, mass graves were used in a non-conflict capacity in Britain during the plague epidemic of the 14th century. These plague pits varied in the presence of ritual behaviour and order throughout the country. This example of mass burial behaviour is similar to what Turner and Turner (1998) define as a considerate burial – a burial that has any of four basic elements: patterned body positioning; a defined place where the dead are buried; presence of grave goods; and fully articulated skeletons (1998: 40).

Another characteristic of a hostile burial is that it may be intentionally located in a secluded or sparsely inhabited area if it contains victims of extra-judicial killing. In addition, grave depth will vary according to the type of excavation; hand-dug graves may be shallower, while those dug with heavy equipment may be deeper. Depth may also relate to the number of individuals interred. There may be instances when the soil cover is so shallow that the remains are partly exposed.

### Intentional obscuration

The other grave variable, intentional obscuration, can take on different forms. Multiple periods of interment will not only obscure an initial burial by subsequent digging and the placing of additional bodies, but the original bodies may have decomposed between episodes, and as such, may have been dug up with the top layer of fill and then re-deposited over subsequently buried remains. This will not only result in some bodies being removed or disarticulated, but will obscure a clear definition of the periods of interment. The burials at Church and the Priory of St. Andrew, Fishergate, York are a good example of five centuries of interment periods creating a complex site (Stroud and Kemp 1993). Subsequent use of the area is an additional form of obscuration, such as the placement of roads, quarrying, and development, such as the mass grave found under Towton Hall, Towton, North Yorkshire (WYAS 1997: 1).

Additionally, a grave may contain miscellaneous artefacts that had nothing to do with the burial, or events surrounding burial. For example, the fortification trench that served as a mass grave for the victims of the Crow Creek massacre (an early-15th century site along the Missouri River in present-day South Dakota, USA), was used, before and after the massacre, as a trash midden (Zimmerman et al. 1981: 78-79). This shows once again the need to analyse burials as a context of behaviour, for the trash obscuring the burial here could be easily misconstrued as intentional obscuration.

The examples above are a form of obscuration motivated by the necessity to use, or re-use, the area. There are other instances, however, where these forms of obscuration are used to disguise a burial, as in the case of three graves at Pakračka Poljana, Croatia, which were extra-judicial killings. Here, trash was used to cover them (Fenrick et al. 1996).

Obscuration alone cannot indicate the burial circumstances, as the intent may range from indifference to criminal, but it is still important to note because it helps to define the context of the burial.

#### 2.4.1.2 Remains Variables

##### Age and Sex

Age and Sex (representing the biological sex of an individual) are two variables used to create a representation of the population in the grave. Age and sex classifications are based on the estimations and designations made in reports.

##### Status

The status variable identifies whether an individual is civilian or military. The decision is made based on a combination other variables such as age, sex, and the presence of markers such as specific types of clothing and/or equipment.

It may be assumed that in the normative context, the status of most individuals will be 'civilian', while those in conflict period friendly burials will be 'military', but it is necessary to examine the burial context first. Civilian victims of conflict may receive the same treatment as military victims – especially if the burials are conducted by neutral or hostile groups.

### Cause of Death

There are 24 causes of death represented in the variables, ranging from gun shot wounds, blunt trauma to sickness and disease and natural causes. These specific causes fall into one of four general categories representing the manner of death (e.g. combat related, sickness, extra-judicial, and natural). Many of these causes are limited by the period from which the data comes. For example, a gunshot wound is not possible in a medieval burial. On the other hand, blunt trauma to the head in a medieval burial may suggest an origin in combat, whereas in a late 20th century burial it is more likely to be extra-judicial.

Defining the attributes present in a normative burial is simpler than defining the more complex situations of conflict period burials. It is expected that the normative burials would be mainly the result of illness, accident, or natural causes. Conversely, it is expected that most conflict period friendly burials would exhibit combat-related causes of death, while conflict period neutral and hostile burials would additionally exhibit extra-judicial causes of death.

### Mutilation

Mutilation, as defined here, is peri- or post-mortem trauma (defacement) deliberately inflicted upon the deceased, prior to or immediately after death.

It is expected that mutilation of remains would be mainly confined to hostile burials, unless the victims were recovered after death by friendly groups. In this study, a majority of individuals with mutilation marks were United States cavalry soldiers who died at the Battle of the Little Bighorn. While they were buried by other soldiers, a gap between the time of death and primary burial allowed the American Indian victors to take trophies from the bodies.

While this case is exceptional, it does emphasise that mutilation does not always signify hostile burial circumstances and therefore interpretation of the burial circumstances requires additional contextual evidence.

**Body Position Variables**

The variables used to describe the disposition of the remains in the grave are arm position (referring to upper limb positioning), head position, general body position, articulation, and orientation (see Appendix B for definitions of variables and entries). The element variables (arm, head, and body) give a broad indication of how the body was placed in the grave, and articulation indicates just how much of the skeleton remains for observation.

Body treatment is a strong indicator of the identity of the buriers. It is assumed that friendly groups will know, and follow as much as possible, the normative routines and rituals. Neutral and hostile groups may not, however, know such details. For example, the direction the bodies face in a normative burial would not be of consequence to a hostile group disposing of bodies, so the orientation would not likely be consistent or correct. Even if such groups had the necessary knowledge (as opposing forces did in Europe during World War II), order among bodies and normative positioning would not be expected, since this would require additional effort. In some instances, treatment of the body could also be used as a message to others (through vulgar treatment/positioning of body and/or artefacts).

Again, assigning a particular state of a variable (present or absent) to a conflict period neutral burial is difficult. While there may not be an overt disregard for the victims, the buriers may not be aware of the mortuary process, and so the only evidence might be attempts at order, such as placing the bodies individually without commingling or layering.

Another aspect of body position is the presence of the super-positioning of burials or remains. The forms are described by the variables Commingling, Top/Middle/Bottom (TMB), and Right/Centre/Left (RCL), which both describe the location of an individual in relation to other remains in the grave where commingling is present.

Super-positioning may occur in friendly contexts because the burial place is most important, or because there are an overwhelming number of dead. In the latter case, the bodies may be laid neatly in rows, with any commingling taking place as the remains break down. Conversely, the dead in a hostile context may be dumped into pits or trenches, where they will eventually commingle more extensively.

It is important to note that there are many definitions for normative body positioning and the subsequent meaning behind particular manifestations identified in burials. As Ucko (1969) notes:

> many other methods exist, beyond that of placing a body apart or not burying the body at all, to differentiate categories of people. ...The archaeologist often assumes that the significant features of orientation are the direction of the head and the way the corpse faces; ethnographically, there are many different ways of orientating a body apart form these two more obvious ways (Ucko 1969: 271).

In his paper on grave orientation, Rahtz discusses the differences and the possible reasons for those differences in orientation, such as age, rank, social status, or manner of death (1978: 2). Other factors that can influence orientation are natural features, settlements, monuments, buildings or religious structures (Rahtz 1978: 3). There appears to be a tendency for graves to be placed in an east-west orientation, and he suggests from his examples that burial according to solar orientation, represented in an east-west burial, is a common characteristic through time and space (Rahtz 1978: 4). One important variation is the Muslim practice of placing the body so that it lines up with the holy site of Mecca in Saudi Arabia. This orientation depends on where in the world a person is buried; hence, Muslim burials will exhibit a significant amount of variation in normative grave orientation.

#### 2.4.1.3 Ritual Markers

**Grave Marker**

Grave markers, such as tombstones and crosses, are common elements of burials. Under normal conditions, they would be inscribed with the name and other details of the deceased. During conflicts, however, markers may be improvised from materials at hand, and then at the end of hostilities, these temporary markers may be replaced by permanent ones – unless they have been removed or destroyed.

Grave markers are obvious indications of friendly burial contexts. In Western countries, a military gravestone is often a plain concrete marker with the individual's name, rank, and date (birth and death). For World War II dead, the gravestones may be in the shape of a crucifix (Christian) or the Star of David (Jewish); in other cases, these symbols may be engraved on the headstone (Rugg 2000; Tarlow 1999).

The absence of grave markers suggests burial by neutral or hostile groups, who would act more expediently and, in any case, would not likely know the names or affiliations of the dead.

**Container**

A container may be a coffin, a shroud, or other ritually sanctioned holder for a body. The use of a container strongly suggests that the burial is friendly because it would indicate a significant degree of effort and reverence toward the victims. Of course, in a conflict situation there might not be the time or resources to follow the normative procedures, so the absence of a container alone is not sufficient proof of intent. It is also possible that at the cessation of conflict warring groups will bury the dead with some care regardless of their affiliation.

**Clothing**

In a conflict situation, it is expected that an individual would be buried in the clothes they died in, for reasons of expediency. If the grave consisted of legitimate war casualties, i.e. soldiers, the bodies would be in military dress, but this might not always be the case, especially when the fighters were not in a formal army. The presence or absence of clothing, or specific articles of clothing, may contribute to evidence of intent. For example, in Christian mortuary contexts it is the norm to bury fully clothed, while it is common within Islam to be buried in a shroud without clothing. Another pertinent example of the absence of clothing is in the Medieval burials. Not only were medieval burials placed in a shroud without clothing, but taphonomic processes would destroy organic materials such as clothing thereby destroying evidence of this behaviour in both normative and conflict burials.

**Grave Goods**

Grave goods, if ritually prescribed, are items that would be placed in or around a burial. The presence of such artefacts strongly suggests a friendly context. However, the absence of traditional grave goods again does not indicate the opposite, as there may be a lack of time or materials to perform normative rites or the buriers may fear retaliation – under conditions of occupation – if such traditions are exposed to public view. The absence of grave goods in neutral and hostile situations, as with grave markers and ornaments, may reflect different intentions. In the case of a conflict period neutral burial, grave goods may be absent because the burier had no knowledge of the appropriate actions. However, in the case of a conflict period hostile burial, which is merely perfunctory, ritual behaviour may simply not figure into the process.

The presence and the absence of grave goods convey different messages, and sometimes, no message at all. Chapman addresses the complexity of the situation regarding the meaning of grave goods by posing the question: "how far, and for what reasons, are grave goods used as symbols of the social status of the deceased?" (Chapman 1987: 205). Conflict situations add a new dimension to that question.

**Miscellaneous Artefacts**

Unlike grave goods, which may be present under normative conditions, miscellaneous artefacts are objects and materials that would not normally be present in and around a normative or friendly conflict period burial. Depending on the burial tradition, such items may include ordnance, wallets, photos, documents, or in some instances rubbish or animal carcases. It is expected in a neutral or hostile burial that the items on a person when he/she died would be buried with them, excluding valuables and, possibly, identification, since the removal of such items would not be of much concern in those situations. Bodily decomposition before burial may also discourage the stripping of the body, resulting in a scatter of artefacts in the grave. In extra-judicial killings, which commonly occur at the place of burial, shell casings or other artefacts associated with the killing may be dumped with the body in the grave.

**Discussion**

The analysis of a conflict burial using the variables discussed above, which relate to the evidence of intent, will contribute to the identification of the type of burial context (friendly, neutral, or hostile). Intentional behaviour relates to actions purposefully enacted during burial, whether in a conventional normative setting or under pressure because of conflict situations or the threat of disease. However, the analysis is complicated by the fact that some of these attributes and artefacts may be present in any of the burial circumstances. Separating the normative from the three conflict period burial types is possible because of the expectation that all traditional practices will be followed in ordinary circumstances. Separating friendly burials from neutral and hostile burials is also possible to the extent that in a friendly context, the buriers may be expected to follow at least some of the normative practices, while neutral and hostile buriers will demonstrate antipathy or indifference towards the deceased by their failure to follow such steps. Neutral and hostile burials are more difficult to distinguish, as the differences relate to the attitude towards the dead by those responsible for burial (apathy versus hostility), which may only present itself in such variables as mutilation. A further complication occurs when a victim of summary execution or an extra-judicial death, which may be indicated by trauma such as a close range shot in the back of the head, is recovered and buried in a friendly or neutral context.

Taken as a whole, however, the conflict burial model can be used as a method to analyse burial practices of a region, culture, or religion by identifying deviations from normative traditions. The model shows that burial practices related to conflicts have their own distinctive characteristics, suggesting that the methods and techniques should be applicable to gravesites where the circumstances of burial are unknown. These include secret burials, suspect burials (where the gravesites have been given the appearance of conventional burials to hide evidence of atrocities), and historic burials. What is most important is the investigation of the entire burial context, which includes variables associated with the physical and behavioural aspects of death and burial.

### 2.4.2 Burial Models

#### 2.4.2.1 Normative Burials

Cross-culturally, societies respond to death and grief with prescribed attitudes, manners, and rituals (e.g. Binford 1971; Hodder 1980; Pader 1982; Shepherd 1999). These practices and reactions are experienced on an individual level, but still within the context of the society as a whole (Rosenblatt et al. 1976: 12; see also Palgi and Abramovitch 1984). The commonality of reactions cross-culturally illustrates the meaningful and expressive nature of the impact of death (Huntington and Metcalf 1979: 1). A normative burial is therefore the characteristic burial of a particular social group, as manifested in existing cemeteries constructed during peacetime. Geography, religion, and social systems all influence burial practices.

Cemeteries are cultural institutions that may symbolically dramatise many of the community's basic beliefs and values about what kind of society it is, who its members are, and what they aspire to be. People are, in some contexts for instance, stratified in death as they are in life. This stratification is evident in the segregation of cemeteries by race, ethnicity, religion, sex, and social class.

The normative ritual represented in the model consists of behaviour that is visible in and within the immediate area of the grave; it does not include those aspects of ritual behaviour that leave no material trace. Consequently, the model is limited to what is represented within the confines of a cemetery, if applicable. Table 2.1 identifies the attributes that comprise the model for normative burials. There are some exceptions or variations to this model within the data used here (e.g. absence of clothing in the normative Medieval data); however, for the majority of the data, the model represents many of the aspects of normative mortuary behaviour.

| | |
|---|---|
| **Cemetery Type** | Permanent Cemetery; Traditional locale |
| **Obscuration** | Absent |
| **Grave** | Single Plot: one body |
| **Markers** | Present |
| **Normative Container** | Present |
| **Traditional grave goods** | Present |
| **Grave Goods** | With body: coins, flowers, plants, herbs, offerings |
| **Miscellaneous Artefacts** | Absent |
| **Clothing** | Placed in best clothing |
| **Cause of Death** | Natural; Sickness/Disease |
| **Mutilation** | Absent |
| **Body Positioning** | Normative: Consistent pattern in the orientation of bodies |

**Table 2.1** Characteristics of the Normative Burial Model

**Conflict Burial Types**

How one disposes of those killed in conflicts depends upon whether the victims are compatriots or not, whether interment is during or after battle, and whether it is in friendly or enemy territory. There may be other contributing factors including the season and ground conditions, the tools allotted for the task of burial, and when during the period of conflict the burial takes place, but attitudes to the dead figure most prominently, because burial generally follows social prescriptions of some kind. Variation between conflict friendly, neutral, and hostile burials can ordinarily be determined by evaluating the archaeological remains according to the normative standards of the groups involved, which may be based on archaeological, cultural, or historical research or by analogy with other archaeological studies. If one can define the context and appearance of a conventional burial – a normative burial – that follows the religious conventions of the society, it may be possible to identify anomalies in conflict burials, features that do not follow the culturally prescribed material culture for the treatment of the body. Such anomalies may appear in the way victims were killed, how the bodies were prepared for burial, where and how they were interred, or what kinds of grave goods were deposited – reflecting the fact that the buriers did not know, or follow, the conventional steps in the preparation of the body and the interment.

It is important here to emphasise the importance of the ideological context, even though such information may not be manifested directly. A burial that takes place in a normative setting is made up of a series of complex features that includes subjective data such as attitudes towards the individual, their position in the society relative to those conducting the burial, and the society's behaviour towards death and burial. Friendly burials during a conflict period may therefore follow the general social prescription, but have some differences associated with these subjective aspects of the social context – as Walker and Lucero (2000) suggest about the life history of structures:

> To distinguish between warfare and ritual abandonment, for example, one could consider a series of linked deposits in a structure such as whether whole, fragmentary, or no artefacts were present on the floor; whether it was burned or not; and finally, whether or not there were whole artefacts, fragmentary artefacts, or no artefacts in the fill between floors. Difference between deposits would distinguish one

> structure's life history from another's (Walker and Lucero 2000: 136).

Similar differences are represented in the conflict burial types described in the models below.

Furthermore, the distinction between burial types may not be clear. For example, a hastily prepared friendly burial may lack many of the markers of respect and so resemble a neutral or hostile burial. Some evidence may be similar, such as the presence of backhoe marks in a modern grave trench, but distinctions may emerge with the analysis of the contextual and spatial data that archaeology provides in the nature of body treatments (e.g. body positioning, cause of death, mutilation) and ritual markers (e.g. grave goods, grave markers, container) to identify burial types. The context of the site is as important to the interpretation of the site as the artefacts, since the interpretation of a burial extends beyond the gravesite into the culture.

The first model describes the expected characteristics of a grave by friendly groups during conflict periods, the second describes what is expected in a grave prepared by a neutral group, and the third describes hostile burials. The normative burials of the region or culture provide a means of comparison. Primary variables will be order (e.g. layering, commingling) within the grave, manner of death, presence or absence of ritual markers, grave type, and body treatments.

#### 2.4.2.2 Conflict Period Friendly Burial Model

The friendly conflict burial model closely resembles the normative burial model, with some differences, such as a higher prevalence of weapons and explosives trauma as causes of death, and indicators of hastier treatment because of the pressures of conflict situations (see Table 2.2 for Conflict Period Friendly burial attributes). Time may be limited for the burial of comrades because of fear of resumed hostilities, a high number of victims, or the fear of disease from exposed remains. However, it may be expected that a friendly burial will still have some evidence of attempts at conventionality. As Mathew Johnson observes ritual in conflict burials

> ...appeals to fundamental values that are part of the normative belief system may be definitive in a situation of conflict, differentiating one's own group from the adversary, giving the group cohesion, and providing a sense of mission. For the individual, such appeals unite him or her to the group as a whole, through its past, present, and future, and define his or her own responsibility within that group's corporate life (2000: 167).

The level or extent of this intentional behaviour, in the form of grave construction, body orientation or artefacts, may vary throughout a grave (single, multiple or mass) or a cemetery. The differences between Turner and Turner's (1998: 40) 'considerate' burial and a 'friendly' burial, as used in this study, are not only the presence of conflict as a backdrop to action, but also the suggestion of *who* was responsible for burial.

| **Cemetery Type** | Temporary/Non-Normative or Traditional locale |
|---|---|
| **Obscuration** | Absent |
| **Grave** | Single or Mass Grave (multiple bodies) |
| **Markers** | Present or Absent |
| **Normative Container** | Present (few in number) or Absent |
| **Traditional grave goods** | Absent (or few in number) |
| **Grave Goods** | Flowers |
| **Miscellaneous Artefacts** | Present or Absent |
| **Misc. Artefacts** | Personal items (e.g. wallet), armaments |
| **Clothing** | What victim died in |
| **Cause of Death** | Combat Related; Extra-Judicial |
| **Mutilation** | Present or Absent |
| **Body Positioning** | Normative: Signs of an attempt for order within graves; |

**Table 2.2** Characteristics of the Conflict Period Friendly Burial Model

The meaning that artefacts give to a burial may also vary within a single cemetery. It is important to note here that variety in burial rituals and grave goods may not appear because of a religious sense of the afterlife, but as a display associated with the living; as such, the purpose of grave goods may not be very clear. Peter Ucko illustrates this idea in his discussion of burial practices among the Lugbara of Uganda. "Burial... has little or nothing to do with the belief in an afterlife, and tomb goods have no purpose connected with the after-world; they are simply the visible expression of part of a person's social personality, the visible expression of his having left the living" (Ucko 1969: 265). In addition, variation in the types of artefacts represented may have as much significance in patterning and interpretation as similarity in artefacts (Pader 1982: 199).

### 2.4.2.3 Conflict Period Neutral Burial Model

The situation in this burial type is one of an expedient burial by neutral parties during and following hostilities, and as such, it is the most difficult to define and to identify because of the strong similarities between this burial type and both conflict period friendly and conflict period hostile burials. The neutral model will have few, if any, cultural indicators reflecting the normative burial practices of the deceased, and it may have evidence of hasty interment because of the pressures of the conflict situation (see Table 2.3 for Conflict Period Neutral burial attributes).

| | |
|---|---|
| **Cemetery Type** | Temporary/Non-Normative<br>Non-traditional locale |
| **Obscuration** | Absent |
| **Grave** | Mass Grave: multiple bodies |
| **Markers** | Absent |
| **Normative Container** | Absent |
| **Traditional grave goods** | Absent |
| **Grave Goods** | -- |
| **Miscellaneous Artefacts** | Present |
| **Misc. Artefacts** | Personal items (e.g. wallet), armaments |
| **Clothing** | What victim died in |
| **Cause of Death** | Combat Related; Extra-Judicial |
| **Mutilation** | Present or Absent |
| **Body Positioning** | Not Normative: No consistent order in graves; Signs of attempt; Layering and Commingling |

**Table 2.3** Characteristics of the Conflict Period Neutral Burial Model

One example of the difficulty in differentiating between a neutral and hostile burial is the graves at the concentration camps in Europe after the end of World War II. Following the liberation of the Bergen-Belsen concentration camp in April 1945, British soldiers used bulldozers to aid in the burial of victims of the Nazis because of the sheer number of victims and the fear of the spread of disease. The lack of grave goods, containers and the use of a mass grave might otherwise suggest a hostile burial rather than neutral – hence the perceived difficulty in identifying this burial type.

#### 2.4.2.4 Conflict Period Hostile Burial Model

This grave type defines burial by hostile groups in either combat related or extra-judicial circumstances. Such burials may be expedient for sanitary reasons, intentionally bizarre to insult adversaries, or disguise evidence of a criminal action. A hostile burial can therefore be expected to manifest the minimum of effort and reverence. There would be a lack of ritual markers present and body treatments would also reflect a more hostile attitude toward the dead.

Distinguishing conflict period hostile burials from normative and friendly burials, as defined in Table 2.4, is possible because of the stark differences in attributes, especially in comparison to normative behaviour. In a hostile burial, whether clandestine or simply a burial during hostilities, the remains are not likely treated with any regard for the deceased. However, the differences between neutral versus hostile burials is much more difficult to separate since these two types of burials can be expected to contain many of the same characteristics, such as the use of a mass grave.

| | |
|---|---|
| **Cemetery Type** | Temporary/Non-Normative Non-traditional locale |
| **Obscuration** | Present |
| **Grave** | Mass Grave: multiple bodies |
| **Markers** | Absent |
| **Normative Container** | Absent |
| **Traditional grave goods** | Absent |
| **Grave Goods** | – |
| **Miscellaneous Artefacts** | Present |
| **Misc. Artefacts** | Personal items (e.g. wallet), armaments, trash |
| **Clothing** | What victim died in |
| **Cause of Death** | Extra-Judicial; Combat Related |
| **Mutilation** | Present or Absent |
| **Body Positioning** | Not Normative: No consistent order within graves; Layering and Commingling |

**Table 2.4** Characteristics of the Conflict Period Hostile Burial Model

**Discussion**

The appropriateness of the four burial types proposed for the model (normative, conflict friendly, conflict neutral, and conflict hostile) (see Table 2.5 for characteristics of the four burial type models) were tested, as outlined below, by linear and non-linear statistical analysis of specific burial variables derived from a general study of the literature. Statistical techniques were applied to determine whether discrete variations in mortuary behaviour are detectable by quantitative analysis and to develop a suitable methodology that could contribute to the effectiveness of the model for large datasets.

## 2.5 Conclusion

There is the need to develop and apply new and more comprehensive models to the study of conflict period burials, whether prehistoric, historic, or modern. The most common approaches have concerned the identity of the deceased and the cause of death (forensic archaeology) and matters of social identity and status (prehistoric and historic archaeology). Unfortunately, these approaches do not account for all the variables, situational and cultural, that make up the complex behaviour surrounding death and burial in conflicts. As a result, there is a lack of conflict burial data with a sufficient level of quality to support analysis, not because of the lack of good methodology for excavation as much as a lack of a good model for interpretation. The model presented in this thesis is designed to address this problem, with the further goal of fostering the development of new techniques in the excavation and interpretation of conflict graves.

The burial model analyses anomalous grave types from a series of variables and characteristics from data collected to be compared to the characteristics of normative burials for each of the periods studied. The focus of the conflict burial model is body treatment (such as body positioning and cause of death) and ritual markers (such as grave goods and markers). These patterns of behaviour are applicable to all models and present in some form in all data. It is through these treatments that clues to the events that occurred and who was responsible for burial can be ascertained.

| | Normative Burials | Friendly Burials | Neutral Burials | Hostile Burials |
|---|---|---|---|---|
| **Cemetery type** | Permanent; Traditional locale | Temporary/non-normative or traditional locale | Temporary/non-normative Non-traditional locale | Temporary/non-Normative Non-traditional locale |
| **Obscuration** | Absent | Absent | Absent | Present/Absent |
| **Grave** | Single plot: one body | Single or Mass Grave (multiple bodies) | Mass grave: multiple bodies | Mass grave: multiple bodies |
| **Markers** | Present | Present or Absent | Absent | Absent |
| **Normative Container** | Present | Present (limited) or Absent | Absent | Absent |
| **Traditional grave goods** | Present | Absent (or few in number) | Absent | Absent |
| **Grave Goods** | Flowers, plants, offerings | Flowers | -- | -- |
| **Miscellaneous Artefacts** | Absent | Present | Present | Present |
| **Misc. Artefacts** | -- | Personal items (e.g. wallet) armaments | Personal items (e.g. wallet) armaments | Personal items (e.g. wallet) armaments, trash |
| **Clothing** | Placed in best clothing | What victim died in | What victim died in | What victim died in |
| **Cause of Death** | Natural; Sickness/Disease | Combat Related; Extra-Judicial | Combat Related; Extra-Judicial | Extra-Judicial; Combat Related |
| **Mutilation** | Absent | Absent or Present | Absent or Present | Absent or Present |
| **Body Positioning** | Normative: Consistent pattern in the orientation of bodies | Normative: Signs of attempt for order in graves; commingling | Not Normative: No consistent order in graves; Layering and commingling | Not Normative: No order in grave; Layering and commingling |

**Table 2.5** Characteristics of Normative, Conflict Period Friendly, Neutral, and Hostile Burial Models

In addition, the application of comparative archaeological analysis to the study of graves, distinguishing normative burials from either hastily prepared or clandestine ones, can add further understanding to the actions that took place during conflict periods. Such analysis may reveal whether casualties were caused by the effects of battle or by specifically criminal behaviour.

> Each burial may have its own features of interest, but its main contribution normally lies as part of a larger understanding of the diagnostic characteristics of a particular period, population, or cultural group. This understanding will be the successful outcome of the research design. Provided that the evidence has been gathered accurately and comprehensively, the burial effectively becomes a statistical data set and is rarely used in isolation (Hunter 1999: 211-212).

Objects and their meanings are not static entities. Meanings change with different contexts, and it is this ever-changing definition of objects within different contexts and times that is a chief aspect of contextual archaeology (Hodder 1987: 8).

The analysis of mortuary behaviour is therefore about more than artefacts and remains. It consists of a body of theory that directs and focuses the archaeology of a burial according to the aims and approach of a particular theory. All the factors discussed above must be examined as individual components of mass graves in order to identify hostile versus friendly burials. The presence or absence of these forms of evidence must be addressed within the context of conflict and hostilities. Furthermore, the motivation behind the burials, i.e. friendly versus hostile, must be examined carefully from the artefacts and body treatments present at each grave, and examined with regards to each situation and conflict.

By understanding humans as social beings, we can determine whether a burial falls within the pattern of normal burial practices in a specific culture. To an archaeologist, deliberate burials are evidence of some form of social process: an expression of respect for the individual or belief in a life after death. Variations in burials, however, may indicate something outside of the norm. Death is recognised as a central dynamic underlying the life, vitality, and structure of the social order. The conflict burial model uses the normative pattern of burial as the basis of comparative context to understand and identify hastily prepared and clandestine burials and other deviations from the norm, such as an extra judicial killing. The method of burial and memorialising "does not represent the transfiguration of the experience of death, but the transfiguration of the dead for the bereaved" (Tarlow 1999: 164) or, as commonly the case in conflicts, for the adversaries. In his studies on the symbolism and heritage of the remains of the Western Front, Saunders notes how the meaning and role of that landscape has changed through time. The battlefield has now become a sacred place of remembrance (Saunders 2001: 46); whereas the burials studied here have all but been forgotten. By recognising the context of burial as this thesis and its analytical model attempts to do, it may be possible to identify previously forgotten and ignored landscapes of death.

Without a sound body of theory, and properly constructed models, the quantitative results will be meaningless. This is because human behaviour cannot be dissected by linear, mathematical algorithms – humans are not binary figures, but complex, thinking, and feeling beings. Hence, the next chapters will outline a method of quantitative practice that helps to identify aspects of human activity, but does not define it.

# CHAPTER 3 DATA REVIEW

## 3.1 INTRODUCTION

The conflict interment model analysed burial data in five datasets from seven different conflict episodes spanning the 15th century to the late 20th century. Each data set represents a different century, type of conflict, culture (including social and/or political groups), and grave type. There was great difficulty in finding a sufficient amount of data with enough information that is not restricted due to the nature of the work; this difficulty in obtaining data accounts for the range of dates and conflict types used in this analysis. The datasets are used to test the applicability of the model to: a) known grave types, in order to discern any common elements to be found in friendly, neutral, or hostile interments; and b) unknown grave types, in order to tentatively identify those responsible for interment and the circumstances surrounding the burials.

Included is a variety of datasets with different interment situations for the model testing. These situations are: known friendly burials; known hostile burials (to test the hostile interment parameters); neutral burials; burials where those responsible are unknown; and disturbed burials (to demonstrate how disturbance alters the results of the application of the model). The data were from various sources and had varying degrees of completeness. The goal was to identify possible patterns among these different types of conflict burials through a series of queries developed in the database and multivariate statistical techniques using key variables.

## 3.2 THE DATASETS

The five datasets are: the Battle of Towton mass grave; the Snake Hill mass grave (War of 1812); the remnants of four graves from the American Civil War battle of Antietam; six individual graves from Centreville (Ox Hill), VA (U.S. Civil War); the Battle of the Little Bighorn (Custer Battlefield) graves; four mass graves in three provinces in Spain from the Spanish Civil War; graves from the United Nations military engagement in the Korean peninsula; and several small graves from conflicts in the Balkans, one site in Bosnia-Herzegovina and another site in Croatia

(See Table 3.1). Normative burial situations provide the basis of comparison in the burials analysis model to the conflict data and deviations in the norm represented by the conflict data.

| Region | Name | Burial Type | No. of Individuals | Period (century) |
|---|---|---|---|---|
| Spain | | | | |
| | Benegiles, Zamora, Spain | Conflict | 3 | early-20th |
| | Vadoncondes, Burgos, Spain | Conflict | 6 | early-20th |
| | Olmedillo de Roa, Burgos, Spain | Conflict | 8 | early-20th |
| | Villaviciosa, Asturias, Spain | Conflict | 17 | early-20th |
| | Murelaga, Vizcaya, Spain | Normative | 7 | early-20th |
| | Villanueva, Castille y Leon, Spain | Normative | 27 | early-20th |
| Korean War | | | | |
| | Yongchu-Li District, North Korea | Conflict | 1 | mid-20th |
| | Army Post, Kangwon Province, North Korea | Conflict | 1 | mid-20th |
| | Kujan, P'yongan-Pukto Province, North Korea | Conflict | 11 | mid-20th |
| | Unsan County, North Korea | Conflict | 2 | mid-20th |
| | Chonui, South Korea | Conflict | 1 | mid-20th |
| | Chulwan County, South Korea | Conflict | 1 | mid-20th |
| | Snagyi-Ri Village, North Korea | Conflict | 2 | mid-20th |
| | Kujan County, North Korea | Conflict | 1 | mid-20th |
| | Kujan, South Pyongan Province, North Korea | Conflict | 2 | mid-20th |
| | Kaech'on-Si District, North Korea | Conflict | 6 | mid-20th |
| | Sam Jong Don Village, S Korea | Normative | 28 | mid-20th |
| | Yankton, South Dakota, USA | Normative | 27 | mid-20th |
| Balkans | | | | |
| | Bosanski Petrovac, Bosnia-Herzegovina | Conflict | 12 | late 20th |
| | Pakračka Poljana, Croatia | Conflict | 19 | late 20th |
| | Tenkovo, Serbia | Normative | 26 | mid-20th |
| | Slovanski Samac, Croatia | Normative | 32 | late 20th |
| | Ricica, Bosnia-Herzegovina | Normative | 30 | late 20th |
| Medieval England | | | | |
| | Towton, Yorkshire, Great Britain | Conflict | 38 | mid-15th |
| | Fishergate, (St. Andrews) Yorkshire | Normative | 35 | mid-15th |
| North America | | | | |
| | Snake Hill, Fort Erie, Ontario, Canada | Conflict | 23 | early-19th |
| | Antietam, Maryland, USA | Conflict | 4 | mid-19th |
| | Ox Hill, Virginia, USA | Conflict | 6 | mid-19th |
| | Little Big Horn, Montana, USA | Conflict | 19 | mid-19th |
| | Prospect Hill, Ontario, Canada | Normative | 39 | mid-19th |

**Table 3.1** Datasets

### 3.2.1 Spanish Civil War

#### 3.2.1.1 Spain

- Olmedillo and Vadoncondes (Burgos), Villaviciosa (Asturias), Benegiles (Zamora), Spain
- Spanish Civil War – 1936-1939
- Four graves
- Thirty-four individuals - all civilian status

Teams comprised of members from the University of the Basque Country, Association for the Recovery of the Historical Memory, Society of Sciences Aranzadi and volunteers excavated four graves between July 2003 and August 2004.

The dataset graves from the Spanish Civil War are examples of conflict burials during the 20th century prepared for, and by, fellow Christian Spaniards. The burials are primary graves of almost completely articulated individuals. According to several eyewitness accounts, the interments occurred shortly after death, which may contribute to the high level of articulation among the bodies. There was some damage to six sets of remains at two of the sites, however. The graves are from four locations from Northern Spain: Benegiles, Vadoncondes, Olmedillo, and Villaviciosa (Figure 3.1). The Benegiles grave contained three individuals and the grave dimensions were (2 m x 0.75 m x 2.2m) (see Etxeberria, Herrasti, Jiménez, and Lejarza 2004). The grave in Vadoncondes was (3m x1m x 0.8m) and had six individuals (see Etxeberria and Herrasti 2004b). The Olmedillo grave was (4.5m x 0.8m x 0.8m) and contained eight sets of remains (see Etxeberria and Herrasti 2004a) and the grave in Villaviciosa was (11m x 0.7m x 1m) and had 17 individuals (see Etxeberria, Herrasti, and Lejarza 2004).

Three of the four graves are examples of conflict graves during the early 20$^{th}$ century prepared by hostile forces outside the confines of a cemetery. The fourth grave is also a mass grave during a conflict, but it is located within a cemetery prepared by unknown individuals.

The Spanish data is used here because of the extensive excavation and recording procedures implemented at the site. The data include all the information required for the burials analysis database – i.e. grave, skeletal, and artefact data. There are thorough descriptions of the articulation, orientation, location, and juxtaposition of the remains within the grave, as well as pathology, age, stature and ante- and peri-mortem trauma data. The data also include maps of individual locations in the grave, as well as the entire composition of all the remains within the grave. The site was thoroughly mapped and recorded within the context of its geographical location and detailed maps (sketch and/or computer generated) were produced. In addition, coordinate data for the remains and artefacts were extrapolated from the map figures to supplement the descriptive locations.


**Figure 3.1** Location of the four burial sites in Spain (CIA 2005)

### 3.2.1.2 Normative Spanish and Basque Burials

- Murelaga, Vizcaya, and Villanueva, Castille y Leon, Spain
- Thirty-four graves
- Thirty-four individuals - all civilian status

A composite dataset was created from ethnographic studies to represent both normative Spanish and Basque burial practices for the early 20th century period. The data was created from information from *Death in Murlega* (Douglass 1969) for the Basque region of Spain and *Gender Distinctions in Monteros Mortuary Ritual* (Brandes 1981) and *Modern Slab Burials in Northern Castile* (Aitken 1935) representing Spanish burials.

The dataset is the normative comparison for the graves from the Spanish Civil War 1936-1939. There are seven individuals in single graves of relatively uniform size (1.75m x 1m x 0.9m) representing burials in Murlega. There are 27 individuals in single graves of relatively uniform size (1.69m x 0.9m x 0.9m) representing burials in the Castile region of Spain.

The questions asked of the Spanish dataset are:

- What were the conditions under which the burial took place, was it during a battle, or immediately after a battle?
- Is there a correlation between status and the treatment of the body, the level and/or of trauma and/or cause of death?
    - Looking at: Cause of Death; Body positioning; artefacts
- Is there a recognizable difference in burial treatment because of the type of conflict, *i.e.* International versus a civil war?

Since the actions and movements of troops were well documented during the Spanish Civil war, an additional question is:

- Can the stage of the conflict be identified,from the location and state of the remains?

### 3.2.2 Korean War

In addition to the twenty-two sites that make-up the conflict dataset for Korea, there are two normative sites used to represent two major ethnic parties involved (Korean and American) in the conflict that are included in the conflict period data.

#### 3.2.2.1 Korea

- Chulwan County, South Korea; Kangwŏn-do, Pyŏngan-Namdo, Hwanghar-Bukto, and Kaesŏng-Si provinces, North Korea
- Korean War – 1950-1953
- Twenty-two graves
- Twenty-eight individuals - all military status

The Korea dataset consists of graves of American soldiers in different parts of the Korean peninsula (primarily North Korea) (Joint POW/MIA Accounting Command, n/d). The graves, which varied in size and shape, were prepared by unknown individuals under unknown circumstances between 1950 and 1953 during hostilities between United Nations forces (consisting of many nationalities) and forces from North Korea and China (Figure 3.2).


**Figure 3.2** Location of twenty-two burial sites in North and South Korea (CIA 2005) (Twenty burials in area highlighted by black circle)

The burials vary in all of the parameters of the model, but the primary variables are location, dimensions, level of articulation and position. There does not appear to be a pattern in the type of burials present (e.g. primary, secondary graves) or when the grave was prepared, such as during or shortly after battle. Another complication is that because of the fluidity of the conflict, and that the cases are not from major, identifiable incursions, there is little information about the circumstances surrounding the death of the individual. Furthermore, little is known regarding the death or burial of the individuals. Many of the graves show episodes of disturbance, and in some cases, removal, by North Korean authorities before exhumation could take place.

The Joint POW/MIA Accounting Command (JPAC) formally known as the Central Identification Laboratory-Hawaii (CILHI) excavated and retrieved the remains over several years in the mid to late 1990's with the cooperation of the North Korean government. The JPAC works throughout Southeast Asia recovering the remains of US servicemen. Lisa M. Hoshower's article in the *Journal of Forensic Sciences*, 'Forensic Archeology and the Need for Flexible Excavation Strategies: A Case Study' (1998), describes a specific case of the retrieval of human remains from the Vietnam War. This article reveals one difference between forensic and archaeological techniques, an instance where mapping is not deemed necessary.

Lisa Hoshower describes the methods that were employed at the scene, which can be considered typical of the recovery aims of CILHI. While a grid was implemented to maintain provenience of remains and artefacts, Hoshower continues, "the precise three-dimensional relationship of artefacts to remains is not recorded for isolated burials. The CILHI anthropologists are not attempting to recreate a crime scene" (1998: 54). Furthermore, the association of artefact to remains would not offer new information towards case resolution since the site is often identified by witness testimony (1998: 54). In addition, many times, artefacts that would be expected to present in aircraft crashes are missing, either due to locals retrieving scraps of metal from the plane, or because of the damp conditions of the region, which accelerates decomposition.

The data used consists of thorough descriptions of the articulation, orientation, location, and juxtaposition of the remains within the grave, age, and general peri-mortem trauma data. Photographs taken of individuals *in situ* were used to determine the state (orientation, articulation, general location within the grave and commingling) of the remains since mapping coordinates or maps were not available. Moreover, the data regarding the artefacts immediately associated with the graves were taken from the general descriptions provided.

### 3.2.2.2 Normative Korean Burials

- Sam Jong Don Village, South Korea
- Twenty-eight graves
- Twenty-eight individuals - all civilian status

A composite dataset was created from ethnographic studies to represent normative Korean burial practices for the mid 20th century period. The data was created from information in *Sam Jong Dong: A South Korean Village* (Knez 1960); *Ancestor Worship and Korean Society* (Janelli 1982); and *Mourning and Burial Rites of Korea* (Landis 1998).

This dataset is one of two normative comparisons for the graves from the Korean War 1950-1953. There are twenty-eight individuals in single graves of relatively uniform size (1.7m x 0.7m x 1m).

**3.2.2.3 Normative 20th Century North American Burials**

- Yankton, South Dakota, USA
- Twenty-seven graves
- Twenty-seven individuals - all civilian status

A composite dataset was created from historical studies and fieldwork at a cemetery in Yankton County, South Dakota dating from the mid 19th century to the present to represent normative American burial practices for the mid 20th century period.

This dataset is one of two normative comparisons for the graves from the Korean War 1950-1953. There are 27 individuals in single graves of relatively uniform size (1.72m x 1m x 1.45m).

As the burial situations of the graves forming this dataset are unknown, the questions asked of the Korea data are:

- Who was responsible for the burial?
- What were the conditions under which the burial took place, was it during a battle, or immediately after a battle?
- What was the interment situation and burial type?
- What is the relation of the grave to a conflict locality, such as a battlefield, hospital, or cemetery?
    - Looking at: Grave size; Body positioning; artefacts

Since the actions and movements of troops were well documented during the Korean conflict, an additional question is:

- Can troop movements, and the stage of the conflict be identified from the location and state of the remains?

### 3.2.3 BALKANS

In addition to the two sites that make-up the conflict dataset for the Balkans, there are three normative sites used to represent the three major ethnic groups (Serbian, Bosniak, and Croatian) from the region.

#### 3.2.3.1 Pakračka Poljana, Croatia

- Pakračka Poljana, Croatia
- Conflict in the Former Yugoslavia – 1992
- Nine graves
- Nineteen individuals - two military, 17 civilian

The dataset from Pakračka Poljana consists of a series of graves of Serbian civilians and soldiers along a creek in the Slavonia region of Croatia that were prepared by hostile Croatian forces (Figure 3.3). These hostile forces were responsible for the extra-judicial killings. The graves varied in size and shape with seven containing two individuals each, one grave containing one individual, and one grave with four sets of remains. The graves were prepared over a couple of months in late 1992 during the Balkan crisis.

There is extensive documentation regarding the events leading to the deaths and statements regarding the events and data comprising this site. It is known that Croatian forces were responsible for the deaths and burials of 19 Serbians from the area of Pakračka Poljana. The report *Final Report of the United Nations Commission of Experts established pursuant to security council resolution 780 (1992) Annex X.B. Mass Graves – Pakračka Poljana* (Fenrick 1994) provides a complete description of the context surrounding the burials and exhumation and reports the findings of the subsequent examination.


**Figure 3.3** Location of the burial site in Pakračka Poljana, Croatia (CIA 2005)

The graves were excavated between October and November 1993 by an international team of archaeologists, anthropologists, doctors, and law enforcement personnel under the direction of the United Nations Civil Police. The data that are used consists of thorough descriptions of the articulation, orientation, location, and juxtaposition of the remains within the grave, age, and general peri-mortem trauma data. The report contains descriptions which are used to determine the state (orientation, articulation, general location within the grave and commingling) of the remains since mapping coordinates or maps were not available. The data regarding the artefacts immediately associated with the graves were taken from the general descriptions provided.

As the burial situations of the graves forming this dataset are tentatively known, the questions asked are in order to possibly identify hostile interment characteristics of unknown situations. The questions that will be asked of the Croatia dataset are:

- What were the conditions under which the burial took place, was it during a battle, or immediately after a battle?

- Can troop movements, and the stage of the conflict, be identified from the treatment of the remains?
- Is there a correlation between status and the treatment of the body, the level and/or of trauma and/or cause of death?
    - Looking at: Cause of Death; Body positioning; artefacts

### 3.2.3.2 Bosanski Petrovac, Bosnia-Herzegovina

- Bosanski Petrovac, Bosnia-Herzegovina
- Conflict in the Former Yugoslavia – 1995
- Three graves: 1 single grave (3m x 1.5m x 0.4m); two mass graves (3.5m x 3m x 0.4m) and (8m x 4m x 0.5m)
- Twelve individuals - all military remains

The dataset from Bosanski Petrovac consists of three graves of Serbian soldiers outside of the town of Bosanski Petrovac (Figure 3.4). The graves are in a field across a road from an Orthodox cemetery. The graves were primary burials prepared by unknown forces, which appear to have been disturbed by the inclusion of animal carcases.


**Figure 3.4** Location of the burial site in Bosanski Petrovac, Bosnia-Herzegovina (CIA 2005)

The graves were excavated April 1998 by an international team of archaeologists, anthropologists, doctors, and law enforcement personnel under the direction of Physicians for Human Rights with the cooperation of International Commission on Missing Persons. The data used here consists of thorough descriptions of the articulation, orientation, location, and juxtaposition of the remains within the grave, age, and general peri-mortem trauma data. The report, *Bosanski Petrovac Exhumations of Republika Srpska Commission on Missing Persons* (Kennedy 1998), contains descriptions which are used to determine the state (orientation, articulation, general location within the grave and commingling) of the remains since only sketch maps without mapping coordinates were available. The data regarding the artefacts immediately associated with the graves were taken from the general descriptions provided. There is some documentation regarding the events leading to the deaths and statements regarding the data comprising this site.

One shortcoming of the data was the general level of locational analysis; therefore value judgements were placed on the data in order to create more specific locations for the level of commingling of remains, specific location of remains within the grave, and specific location of artefacts in and outside the grave(s).

As the burial situations of the graves forming this dataset are tentatively known, the questions asked are in order to possibly identify hostile interment characteristics of unknown situations. The questions that will be asked of the Bosnia dataset are:

- What were the conditions under which the burial took place, was it during a battle, or immediately after a battle?
- Can troop movements, and the stage of the conflict, be identified from the treatment of the remains?
- Is there a correlation between status and the treatment of the body, the level and/or of trauma and/or cause of death?
    - Looking at: Cause of Death; Body positioning; artefacts

#### 3.2.3.3 Normative Serbian Orthodox Burials

- Tenkovo, Serbia and Montenegro
- Twenty-six graves
- Twenty-six individuals - all civilian status

A composite dataset was created from ethnographic studies to represent normative Serbian Orthodox burial practices for the late 20th century period. The data was created from information in: *Peasant Life in Jugoslavia* (Lodge 1941); *A Serbian Village* (Halpern 1976); and *Folk Life and Customs in the Kragujevac Region of the Jasenica in Sumdaija* (Pavlovic 1997).

This dataset is one of three normative comparisons for the graves from the war in the Former Yugoslavia during the 1990's. There are twenty-six individuals in single graves of relatively uniform size (1.75m x 0.65m x 1.1m).

### 3.2.3.4 Normative Bosnian Muslim Burials

- Ricica, Bosnia-Herzegovina
- Thirty graves
- Thirty - all civilian status

A composite dataset was created from ethnographic studies to represent normative Bosnian burial practices for the late 20th century period. The data were created primarily from the information in Tone Bringa's (1995) study, *Being Muslim the Bosnian Way* and *Peasant Life in Jugoslavia* (Lodge 1941).

This dataset is one of three normative comparisons for the graves from the war in the Former Yugoslavia during the 1990's. There are thirty individuals in single graves of relatively uniform size (1.7m x 0.7m x 1m).

### 3.2.3.5 Normative Croatian Catholic Burials

- Slovanski Samac, Croatia
- Thirty-two graves
- Thirty-two individuals - all civilian status

A composite dataset was created from ethnographic studies to represent normative Croatian burial practices for the late 20th century period. The data were created primarily from the information in Mary Gilliland's *The Maintenance of Family Values in a Yugoslav Town* (1986) and *Peasant Life in Jugoslavia* (Lodge 1941).

This dataset is one of three normative comparisons for the graves from the war in the Former Yugoslavia during the 1990's. There are thirty-two individuals in single graves of relatively uniform size (1.8m x 0.8m x 1.1m).

### 3.2.4 19TH CENTURY NORTH AMERICA

#### 3.2.4.1 The Snake Hill Site

- Fort Erie, Ontario, Canada
- War of 1812 – 1814
- Twenty graves
- Twenty-three individuals - all military status

The Snake Hill dataset consists of several individual graves of American soldiers prepared by US forces while under siege by the British in Fort Erie, Ontario, in mid to late 1814 during the War of 1812 (Figure 3.5). The majority of burials are single graves of relatively uniform size (2m x 0.7m x 0.6m), with the exception of a grave containing three individuals and another grave with two individuals. The burials are primary graves of almost completely articulated individuals prepared by friendly forces. It appears that the interments occurred shortly after the battle, as some individuals received medical treatment before burial.


**Figure 3.5** Location of Snake Hill burial site in Fort Erie, Ontario, Canada (CIA 2005)

The burial of these individuals by their own forces undoubtedly contributed to the high level of articulation among the bodies. Furthermore, the fact that burials of an invading force remained undisturbed for almost 200 years suggests a lack of animosity towards the dead by the Canadians.

The graves at Snake Hill were excavated by Archaeological Services, Inc (ASI) with contributions from several agencies in both Canada and the United States in 1988. The data originally reported in *The Snake Hill Site: A War of 1812 American Cemetery Vol. I.* (ASI 1988), are used because of the extensive excavation and recording procedures implemented at the site. The data included all the information required for the burial analysis database – i.e. grave, skeletal, and artefact data, as well as documented histories. The site was thoroughly mapped and recorded within in the context of its geographical location and detailed maps (sketch and/or computer generated) were produced. These identify the location of the grave within the confines of either the cemetery or the battlefield. In addition, there are thorough descriptions of the articulation, orientation, and position of the remains within the grave, as well as pathology, age, stature and ante- and peri-mortem trauma data. Photographs of individuals and maps included in the books *Snake Hill: An Investigation of a Military Cemetery from the War of 1812* (Pfeiffer and Williamson 1991); and *Death at Snake Hill: Secrets from a War of 1812 Cemetery* (Litt, Williamson, and Whitehorne 1993), in addition to some of the field notes (ASI 1988) taken during the excavation, were used to determine the state (orientation, articulation, and mutilation) of the remains, and location of remains and associated artefacts using general descriptions. Coordinate data for the remains and artefacts were extrapolated from the map figures to supplement the descriptive locations.

As the graves forming this dataset are composed of burials by friendly forces during a siege on foreign soil, the questions asked of the Snake Hill data are:

- What was the interment situation for each burial: was it primary, conducted hastily or with evidence of ceremony, or a secondary burial?
- Under what conditions did the burial take place – as a mass burial during or shortly after a battle, or was each individual buried separately over time?
    - Looking at: Articulation; Orientation; Body Positioning; Artefacts

In addition, this dataset contributed to understanding the attitude of the invaded about the graves of invaders remaining on their soil.

### 3.2.4.2 Antietam Battlefield (American Civil War)

- Sharpsburg, Maryland, USA
- American Civil War – September 1862
- Four graves
- Four individuals - all military status

The American Civil War battle of Antietam is a mid-19th century North American example of temporary graves of relatively uniform size (2.1 m x 1.1 m x 0.45m) prepared (presumably) by friendly forces (Figure 3.6). These burials are of Union soldiers following three days of battle between the Union forces of the United States and the Confederate soldiers of the Confederate States of America in September 1862. The graves represent two different situations: primary burials (burial immediately after battle); and secondary burials (elements of individuals not retrieved during a mass reburial episode in 1866 or 1867 (Stotelmyer 1992: 21; see also Potter and Owsley 2000: 68).


**Figure 3.6** Location of Antietam burial site in Sharpsburg, Maryland, USA (CIA 2005)

While this is a small sample, four cases, when combined with the Ox Hill dataset, also from the American Civil War, it can produce a significant amount of data regarding burial. This dataset also tested the validity and applicability of the model components and variables of a known situation between individuals within the same culture (in some cases, between relatives). The Antietam data is compared with the data from the Ox Hill data, to determine if both sets of burials were friendly graves prepared by Union soldiers, and if there are any common elements of behaviour present.

Union soldiers placed the remains in temporary field graves immediately following the battle, with the intention of retrieving them for permanent burial at a later date. The four burials lie in an agricultural field north of Sunken Road (within the current Antietam National Cemetery), which was the William Roulette farm at the time of the battle.

Burial details were often haphazard during and following the battle, consisting of trenches and single graves, with or without markers. Following the battle, Aaron Good and Joseph Gill compiled the names and locations of the remains still on the battlefield. The state of Maryland purchased the battle site in 1865 to create a cemetery. The Antietam National Cemetery Board, with the labour of former soldiers, completed the task of reburying the Union soldiers at the newly created cemetery in 1867 (Stotelmyer 1992: 22).

The incomplete remains of the four individuals are believed to be from the Union's Irish Brigade. Stephen Potter suggests this affiliation because the graves were along the axis of the Irish Brigade's attack and because of the nature of the artefacts located with the individuals (Potter and Owsley 2000: 60-70).

The graves from the Battle of Antietam were excavated by the National Park Service, National Capital Region, in August 1988 (Potter and Owsley 2000: 59). Data from this excavation was included because extensive excavation and recording procedures were implemented at the site. The data included all the information required for the burials analysis database – i.e. grave, skeletal, and artefact data, as well as documented histories. There were no surface artefacts in association with the burials since the area was cultivated before and after the battle and until the area became part of the National Cemetery. The site was thoroughly mapped and recorded within the context of its geographical location and detailed maps (sketch and/or computer generated) were produced. These maps identify the location of the graves within the confines of the cemetery and the battlefield. In addition, there are thorough descriptions of the articulation, orientation, and position of the remains within each grave, as well as pathology, age, stature and peri-mortem trauma data. Photographs and maps included in the book *Archaeological Perspective on the American Civil War* (Potter and Owsley 2000) were used to determine the orientation and relation of the graves to each other as well as the general descriptions of the remains and associated artefacts. Coordinate data for the remains and artefacts were extrapolated from the map figures to supplement the descriptive locations.

The key variables for Antietam are: the location of the graves in relation to the battlefield; the nature and orientation of each grave in its setting; the nature and orientation of individual sets of remains within the grave; the level of articulation; and the nature and extent of grave goods.

The questions asked of the Antietam data are:

- Who was responsible for burial?
- What were the conditions under which the burial took place?
- Was the grave in question a primary grave missed during the reburial episode of 1866/67, or one composed of elements and artefacts left behind by the reburial party?
- Is there a correlation between rank and the level of articulation, or rather, the number of elements left behind and not reburied?

#### 3.2.4.3 Ox Hill, Virginia (American Civil War)

- Centreville, Virginia, USA
- American Civil War – September 1862
- Six graves
- Six individuals - all military status

The American Civil War battle of Ox Hill is another mid-19$^{th}$ century North American example of temporary graves of relatively uniform size (2.1m x 0.76 m x 0.65 m) prepared (presumably) by friendly forces (Figure 3.7). These burials are of Union soldiers over an indeterminate period of time during the Union Army's occupation of the area between 1862 and 1863. The graves represent primary burials (burial immediately after death or medical attention). As noted above, when this small dataset is combined with another dataset from the same conflict, it can not only produce significant amount of data but also indicate burial behaviour from this type of context, i.e. burial during battle in a civil conflict.


**Figure 3.7** Location of Ox Hill burial site in Centreville, Virginia, USA (CIA 2005)

The graves are not located in any particular battlefield from the Civil War, but, if the graves are the result of the First Battle of Manassas, they would have been located in the back of the Union Army's lines (Johnson 2000: 26). However, since the exact date of burial is unknown, the purpose of the area at the time of burial is unknown because the area changed function throughout the period of hostilities. For instance, the area from which the bodies were recovered had been the front lines early in the war, but had also been an encampment location for both armies at different times of the war.

Burial details were often haphazard during and following battles, consisting of trenches and single graves, with or without markers depending on the number of dead and the time between battles or retreats. This area of Virginia had several different battles, movements of armies to and from battles, as well as different periods of Confederate and Union occupation.

The remains of the individuals are believed to be from the Union Army. Michael Johnson suggests this affiliation because the graves were in an area that had been the encampment for several Union regiments during the Civil War and because of the associated artefacts located with the individuals (Johnson 2000: 25).

The graves were excavated by Fairfax County Archaeological Services, Park Authority, in January 1997 (Johnson 2000: 1). The data from this excavation are included because extensive excavation and recording procedures were implemented at the site. The data included all the information required for the burials analysis database – i.e. grave, skeletal, and artefact data, as well as documented histories. There were no surface artefacts in association with the burials since the area has been under continual use and has had several periods of construction. The site was thoroughly mapped and recorded within the context of its geographical location and detailed maps (sketch and/or computer generated) were produced. These maps identify the location of the graves within the immediate area. In addition, there are thorough descriptions of the articulation, orientation, and position of the remains within each grave, as well as pathology, age, stature and peri-mortem trauma data. The report *Civil War Burials, Centreville, Virginia 44FX1791* (Johnson 2000) included the general descriptions of the remains and associated artefacts; from the maps in this report the orientation of the graves as well as their relation to each other were determined, and coordinate data for the remains and artefacts were extrapolated from the map figures to supplement the descriptive locations.

The key variables for Centreville are: the location of the graves in relation to the battle lines; the relation of periods of encampment and battles; the nature and orientation of each grave in its setting; the nature and orientation of individual sets of remains within the grave; the level of articulation; and the nature and extent of grave goods.

The questions asked of the Ox Hill data are:

- Who was responsible for burial?

- What were the conditions under which the burial took place?

#### 3.2.4.4 The Battle of the Little Bighorn (Custer Battlefield)

- Little Big Horn river, Montana, USA
- Isolated battle – June 1867
- Nineteen graves
- Nineteen sets individuals - all military status

The Custer Battlefield dataset is a late-19th century North American example of multiple graves prepared by friendly forces (fellow soldiers) following an engagement with pan-tribal American Indians. These graves represent two different situations: primary burials (burial immediately after battle), and secondary burials (elements of individuals not retrieved during a mass grave reburial episode in 1881). The graves are of irregular size and various degrees of articulation of remains.

U.S. Cavalry burial details were active at the battlefield from 1876 to 1881. The first detail, two days after the battle, 28 June 1876, consisted of little more than piling dirt over the bodies (Scott et al. 1998: 97). The second detail was sent out in 1877 to re-bury the exposed remains. In 1879 another burial detail was sent to re-bury exposed remains. In 1881, the final burial detail was sent out to exhume all the remains and place them in a mass grave in what is now the Custer National Cemetery (Scott et al. 1998: 97) (Figure 3.8).


**Figure 3.8** Location of Little Big Horn burial site in Montana, USA (CIA 2005)

The episodes of burial and reburial presented a problem for excavators from the Midwest Archaeological Center (MWAC), who excavated a sample of marked graves and adjacent areas. In 1876, the burial detail placed wooden crosses where they located a body; in 1890 they replaced surviving wooden crosses with concrete markers where they assumed a soldier had died - since there were no survivors from the Custer battle to corroborate the exact location where a soldier fell during battle. Furthermore, each detail produced a sketch map of the grave locations, but the sketch maps do not agree. The result was that the means of distinguishing primary and secondary burials was lost. Compounding this difficulty, confusion between the forces with Lt. Col. Custer and with Captain Benteen (Custer's third in command) resulted in a miscalculation of the number of cavalry dead on the Custer Battlefield. Thirty-nine of the markers on the Custer Battlefield are not associated with any remains (Scott et al. 1989; 1998).

Analysis of the burial situation from the remains is complicated by peri- and post-mortem trauma inflicted on the soldiers and other impacts on the bodies before burial. These include the disrobing of the dead, mutilations, dismemberment and decapitation, and the process of decomposition over a period of two day's exposure in the summer heat (Scott et al. 1998: 104). The result was that from the Custer Battlefield, only 56 (26%) of the 210 bodies were identified at the time of burial, and recent analysis suggests that some of the identifications made in 1876 were mis-identifications (Scott et al. 1998: 105). This is a relatively low identification rate in comparison to the other area of engagement on the battleground, the Reno-Benteen defence site, where 47 of the 53 killed (87%) were identified (Scott et al. 1998: 106-107).

The Custer Battlefield data were used because extensive excavation and recording procedures were implemented at the site. The data included all the information required for the burials analysis database – i.e. grave, skeletal, and artefact data, as well as documented histories. The site was thoroughly mapped and recorded within in the context of its geographical location and detailed maps (sketch and/or computer generated) were produced. These maps identify the location of the grave within the confines of either the cemetery or the battlefield. In addition, there are thorough descriptions of the articulation, orientation, and position of the remains within the grave, as well as pathology, age, stature and ante- and peri-mortem trauma data. There are also tentative identifications of some of the individuals exhumed during the 1984-1985 field seasons. Also used are photographs of individuals and maps included in the books *Archaeology, History, and Custer's Last Battle: The Little Big Horn Reexamined.* (Fox 1993); *Archaeological Insights into the Custer Battle* (Scott and Fox 1987); *Archaeological Perspectives on the Battle of the Little Big Horn* (Scott et al. 1989); and *They Died with Custer: The Soldiers' Skeletons From the Battle of the Little Bighorn* (Scott et al. 1998), in addition to the field notes taken during the excavation, to determine the state (orientation, articulation, and mutilation) of the remains, and location of remains and associated artefacts using general descriptions. In addition, coordinate data for the remains and artefacts were extrapolated from the map figures to supplement the descriptive locations.

Most importantly, this dataset tested the validity and applicability of the model's components and variables to a known situation, which can then contribute to the refining of the model for further testing and analysis of unknown interment situations.

The individuals, or the elements of individuals excavated, were known to have been buried by fellow soldiers immediately after the conflict. Therefore, the primary questions of the Custer Battlefield dataset are:

- Was the grave in question a primary grave missed during the mass reburial episode of 1881, or one composed of elements and artefacts left behind by the reburial party?
- If it is a primary grave, does the grave data provide evidence of the interment situation (e.g. whether the burial was summary or conducted with ceremony)?

There was an additional problem examined through a comparison of the interment to a normative military burial of the time with respect to size, orientation, and grave goods.

An additional question addresses socio-cultural issues in the reburial detail:

- Is there a correlation between a soldier's rank and the skeletal elements left behind by the reburial party?

#### 3.2.4.5 Prospect Hill, Ontario, Canada

- Newmarket, Ontario, Canada
- Thirty-nine graves
- Thirty-nine individuals - all civilian status

Archaeological Services, Inc. (ASI) excavated over 70 individual graves from the cemetery at Prospect Hill in 1989. The data from *Archaeological Mitigation of the Prospect Hill Cemetery, Town of Newmarket, Regional Municipality of York* (ASI 1990) were used. The dataset includes the remains of 39 individuals. The graves were of relatively uniform size and shape (1.9m x 0.73m x 0.47m). The burials that will be used date between 1824 and 1879 and represent a variety of body types and circumstances.

Documents include the report prepared by the ASI, which includes maps, photos, and descriptions. These data will be used to characterise 'friendly' normative burials from the early- to mid-19$^{th}$ century period to compare with the characteristics from the Snake Hill, Antietam, Custer Battlefield, and Ox Hill datasets.

### 3.2.5 Medieval England

#### 3.2.5.1 The Battle of Towton

- Towton, North Yorkshire, Great Britain
- War of the Roses battle – March 1461
- One Mass Grave (5.25m x 2m x 0.65m)
- Thirty-nine individuals - all military status

The dataset from the Battle of Towton is an example of a conflict burial during the 15$^{th}$ century prepared for, and by, fellow Christian Englishmen in Northern England (Figure 3.9). The burial is a primary mass grave of almost completely articulated individuals. The interment apparently occurred shortly after the battle, which may contribute to the high level of articulation among the bodies (Fiorato et al. 2000: 41).

Photographs of individuals from *The Medieval Soldier in the Wars of the Roses* (Boardman 1998) in addition to photographs and maps included in the book *Blood*

*Red Roses* (Fiorato et al. 2000), were used as well as the report *Towton Hall, Towton North Yorkshire* supplied by Western Yorkshire Archaeological Services (1997), to determine the state (orientation, articulation, general location, and commingling) of the remains. Included are the data regarding some of the artefacts immediately associated with the mass grave from general descriptions of the location that were included in *Blood Red Roses* (Fiorato et al. 2000).


**Figure 3.9** Location of Towton burial site in Towton, North Yorkshire, Great Britain (CIA 2005)

University of Bradford archaeologists have suggested that the mass grave is a primary friendly burial (Sutherland 2000: 41) because the grave was relatively large and the bodies were laid in the grave, not simply dumped in. However, Knüsel and Boylston do stipulate that some characteristics suggest a hostile burial. For example, the grave was not on sacred ground, which would have been important to Christians; furthermore, there were individuals in various degrees of articulation and positioning, and there was evidence in some remains of peri-mortem facial disfigurement. Such facial disfigurement suggests that hostile forces had ample time to inflict injuries beyond the mortal wounds sustained in the heat of battle. The excess of facial wounds may be an attempt to depersonalise the victim (Knüsel and Boylston 2000: 185-186). Other characteristics supporting a hostile burial are variation in the orientation of remains in the grave; and the distance of the grave from the battlefield (one mile), which suggests that those buried had died during the rout.

At this time, there is no strong evidence to suggest who buried the men in the Towton mass grave. There are characteristics of hostile burials and characteristics of friendly burials. The issue of a grave comprised of characteristics of both types of burial is possibly explained by the historical information that each side was seen as treasonous by the other, therefore not deserving of a proper burial (Fiorato et al. 2000: 186).

The Towton data are used here because of the extensive excavation and recording procedures that were implemented at the site. The data include all the information required for the burials analysis database – i.e. grave, skeletal, and artefact data. There are thorough descriptions of the articulation, orientation, location and juxtaposition of the remains within the grave, as well as pathology, age, stature and ante- and peri-mortem trauma data. The data also include maps of individual locations in the grave, as well as the entire composition of all the remains within the grave.

The key variables for Towton are: the location of the grave in relation to the battlefield; the nature and orientation of the grave in its setting; the nature and orientation of individual sets of remains within the grave; the nature, degree and extent of mutilation (differentiating between degrees of peri-and post- mortem trauma); the nature and degree of commingling; and the nature and extent of grave goods.

#### 3.2.5.2 St. Andrew, Fishergate, York, Great Britain

- York, Great Britain
- Thirty-five graves
- Thirty-five individuals - all civilian status

Over 400 human skeletons were excavated in 1986-89 from the Church and the Priory of St. Andrew, Fishergate, York by the York Archaeological Trust. The burials took place over a period of at least 500 years. The burials that will be used are those from the early to mid 14$^{th}$ century component. The interments are examples of normative burial practices under different circumstances regarding death and time. There are 35 individuals in single graves of relatively uniform size (1.7m x 0.5m x 0.4m).

Documents include the report *Cemeteries of the Church and Priory of St. Andrew, Fishergate* (Stroud and Kemp 1993) prepared by the York Archaeological Trust, which includes maps, photos, and descriptions. This example will be used to characterise 'friendly' normative burials from the medieval period to compare with the characteristics from the Towton dataset.

The questions asked of the Towton data are:

- Who was responsible for burial?
- What were the conditions under which the burial took place?
- Were the individuals who were buried victims of a massacre, or did they die of the wounds sustained during the battle?
    - What variables would indicate that

## 3.3 CONCLUSION

It was important that there was sufficient information recorded about the sites, and that that data be available. As a result, the available data determined what variables were possible to identify and use to define the burials. Since the types of data were determined by this situation, the focus became that of body treatment. The dataset is very diversified and consists of a total of 434 cases, 183 cases, 89 graves from 33 conflict sites from the five datasets from the seven conflict episodes ranging from 1461 to 1995 and 251 graves from the comparative normative sites. These data, in conjunction with the model, are designed to identify four distinct burial types (normative, friendly, neutral, and hostile).

# CHAPTER 4 STATISTICAL APPROACHES TO THE STUDY OF CONFLICT BURIALS: APPLYING THEORY AND METHODS

## 4.1 INTRODUCTION

The goal of the excavation of conflict graves is not simply the identification of the victims or perpetrators, but the study of the totality of behaviour at the site. The analysis of artefacts, bodies and their spatial relations help reveal the circumstances of the death and burial. Whether the investigation is prehistoric, historic, or a recent forensic case, it must therefore follow the current theoretical and methodological practices of archaeology.

Archaeological data (i.e. artefacts, body treatment, and ritual markers), skeletal data, technical data (i.e. excavation techniques), and environmental data are all necessary in analysis and interpretation, whether a burial is normative or otherwise (Härke 1994: 34). Some of the data are specific to the individual victim, such as sex, age, status; others are related to the death and burial, including the location of the grave, its manner of construction, skeletal positioning, and grave goods (Härke 1994: 34). Since the deaths occurred in a context of violence, these attributes are, in some cases, not easily identifiable, as the remains may be fragmentary, disarticulated, or commingled. Consequently, all of the types of data need to be analysed.

A general problem with such recording is the fact that the object is not the recovery of artefacts, but the remains of people, often within a non-archaeological context (e.g. forensics or recovery of war victims). In this emotive situation, the placement of artefacts within the burial, whether associated with a particular set or remains or not, and study of the entire event, may be ignored.

No matter how precise recording techniques are, archaeologists are influenced in their work by contemporary social and material forces (see, for example, Bradley 1996; James 1996; Molyneaux 1996; Shanks 1996). What is recorded and created can be merely a result of the prior expectations instead of what was actually excavated, or emphasise certain data at the expense of the other elements not regarded as important (Bradley 1996: 68). This is further complicated by the fact that as the researcher is attempting to detect human interaction and variables, the results may convey messages about their own perceptions of the actual conflict and its victims. While there is no standard for how much data are required to accurately position and illustrate the contents of a grave, there is the need to be able to recognise elements and the level of articulation among remains within the burial.

**Intra- and Inter-Site Analysis**

Burial is deliberate behaviour performed by individuals to dispose of a body or bodies. It is from the juxtaposition of remains and artefacts within and around a burial that patterns might emerge and interpretations can be made regarding those responsible for burial and events surrounding the interment. Furthermore, these patterns may re-emerge in other sites, allowing for predictive modelling and analysis based on the manner of death and disposal. This change in patterns can be analysed on both the intra- and inter-site levels. Moreover, with the introduction of new technology, new methods and theories emerge.

As noted previously, the patterns that emerge have spatial and temporal aspects. For graves resulting from recent and historical conflicts, the burial characteristics will change depending on the time period and the region under study, but some of the common variables are: who controlled the territory (hostile or friendly) when the deaths and burials took place; the pattern of military and civilian movements during the conflict; and the level of morale among troops. Such variables may determine the nature of the deaths and burials, the location of possible victims and crimes, as well as aiding in the identification of battlefields.

**Intra-site Analysis**

In order to interpret the circumstance surrounding the burials, it is necessary to go beyond simple data recovery techniques that only yield basic positions of bodies and grave objects. The specific articulation of bones and other materials within the soil matrix - the way a body is treated before and after burial, and the relationship of the body to other bodies and other objects and features – may yield information about the actual circumstances of the burial. This detailed analysis takes place at the individual, or intra-site level, since one is examining the situation/events surrounding individual graves and gravesites.

All components from a site need to be used in conjunction with the analysis of trauma, an understanding of the normative burial practices of the region, grave preparation methods, and the artefacts excavated. With these data, one might be able to recognise the manner of death, whether there was one burial event or several, who was responsible for the task of burial, what their attitude to the victims was, or whether there was evidence of selectivity within the grave, based on sex, age, status, or ethnic affiliation, among other things. These analyses and the recognition of patterns based on these variables require a more detailed recording method.

**Inter-Site Analysis**

Larger patterns of burials in a region, combined with historical details on the actual movement of troops in a conflict and the changes in control of territory, may contribute to the understanding of the conflict as well as changing attitudes towards other combatants and civilians. Patterns of certain types of burial sites may indicate such detailed movements, or changes in tactics and troop morale.

## 4.2 Methods of Mortuary Analysis

Statistical analysis of mortuary behaviour has become more sophisticated as the tools become more advanced. With new methods emerging and other methods declining in popularity, it does not appear that one method will be the single answer to all the issues in the analysis of mortuary behaviour. In addition to the change in what statistical methods are being applied to burial studies, the focus of the analysis has also changed.

To illustrate some of the developments in mortuary analysis, the rest of the chapter is divided into three main sections: 1) a discussion of some of the early approaches and methods and more contemporary methods; 2) a review of the preliminary methodology applied to the data and a discussion of the comparative statistical testing techniques (factor analysis, hierarchical, and k-means clustering); and 3) an introduction to neural networks and the technique (Self-Organizing Maps) applied here. The preliminary statistics section includes an introduction to the steps employed in standardising and the coding of the data.

### 4.2.1 Functionalist Approaches to Mortuary Studies

Saxe and Binford used mortuary practices as a way of investigating past social systems, which they do through formal analysis and role theory. Mortuary practices can also be used to recognise the relations between burier and those being buried; this can be done by analysing the context of the variations in the types of society and social complexities (Saxe 1970; Binford 1971). The Saxe/Binford approach defines burials as a clear-cut representation of status and social organisation and it looks for cross-cultural rules, social complexity, and age, sex, horizontal, and vertical dimensions symbolised in burial through the patterns created by the data. The suggestion that social complexity was expressed, or confirmed, in individual burials, became a widespread notion among mortuary specialists.

Expanding on the fundamental approach proposed by Saxe and Binford, Tainter (1975) developed the concept of energy expenditure, the measure of energy spent on burials using multivariate techniques. He applied monothetic-divisive cluster analysis to rank burials of Middle Woodland burials from the Klunk and Gibson mounds in the lower Illinois River valley. Tainter's premise was that:

> the greater amounts of energy expenditure will characterize the mortuary ritual accorded to persons of high rank and that in the archaeological context, variations in energy expenditure may be used to identify variations in social ranking (Tainter 1975: 236).

This approach applies only to situations where one assumes that the people knew the dead; otherwise, high status individuals might be buried in a manner unbefitting of that status. Tainter (1978: 113) states that mortuary ritual conveys information about the status of the deceased, which is invariably subject to noise and distortions. These introductions can induce errors or alter the meaning of the message, and it is important to develop a method to read the information despite the noise. Moreover, if one is placed in a mass grave, everyone in the grave may vary in rank, but be buried the same nonetheless. Furthermore, Tainter assumes that the symbols of energy expenditure will be present, or that reverential items associated with the burials were known to have such status to those responsible for burials, especially if burial was performed by persons not affiliated with the society or social group.

The approaches to mortuary studies increasingly concentrated on broad cultural issues like status and rank, and so statistical analysis became more relevant to interpretation. O'Shea (1984), for example, used association analysis that calculated for each pair of attributes, not individuals, in his study of social structure, stressing horizontal and vertical dimensions symbolised in mortuary behaviour. He also applied monothetic-divisive clustering techniques and principal components analysis to understanding mortuary variability in several North American Indian cemeteries (1984, 1985) while looking at body placement and orientation, body mutilation, artefacts and status (1995).

Similar to the strategy employed by Saxe (1970), James Brown (1971b) used formal analysis to formulate a combination of mortuary attributes in his study of mortuary behaviour in late prehistoric Spiro phase burials in the Eastern Woodlands of the United States. He used skeletal treatment and grave goods to suggest ranking; he also used monothetic-divisive clustering to reflect social distinctions (Brown 1987). He further commented on the difficulty in statistical analyses of burial data because of the amount of assumed cultural information that must be addressed when considering the possible type of analysis (Brown 1987: 298).

Continuing on in this tradition, Feldore McHugh (1999) concentrated only on statistical methods in analysing mortuary behaviours, at the expense of qualitative information. He created a model mortuary dataset to apply multivariate techniques. He concluded that the Jaccard coefficient for cluster analysis and correlations for principal components and correspondence analyses were the best suited to examine the social dimensions of his composite dataset (McHugh 1999: 96). While this may produce results from an 'ideal' dataset with regards to size and complexity, actual life is multilayered, diverse, and dynamic. Furthermore, McHugh analysed the standard subject area of mortuary studies – status. While he was able to demonstrate the applicability of multivariate techniques to his mortuary data he only offered the possibility of a new method to analyse the same questions of horizontal and vertical differentiation and social dimensions.

### 4.2.2 Contextual Approaches to Mortuary Studies

After the initial exploration of statistical techniques in analysing mortuary data, there was another shift in the focus of the study of burials. Chapman advocated an emphasis on developing theory over the application statistical techniques in order to guide and explain those statistical results (Chapman 1987: 199); otherwise the results are just numbers with no meaning. This change of direction then affected what was examined when statistical methods were applied; the focus no longer concentrated solely on individual cemeteries and variation, but looked at ideology, context, and cultural variations represented in mortuary behaviour.

Cluster analysis is a common method for studying patterns of behaviour in mortuary contexts. Voorrips (1987) classified grave subsets using cluster analysis based on the presence or absence of characteristics representing mortuary symbolism, while Huggett suggested that burial attributes, such as age and sex, should be examined in combination (1996: 361). Manly (1996) used cluster analysis to test for randomness in artefact distributions based on the presence or absence of artefacts in graves.

Huggett (1992, 1995, and 1996) used a multiple technique strategy with Anglo-Saxon burials to identify treatment of age and sex, as well as identify the similarities and variability between the remains at 12 Anglo-Saxon cemeteries. He devised a model that differentiated between levels of meaning from function within a burial, which included features that described: group affiliation, individual identity, beliefs system, issues relating to the burial party, and unexplained features (Huggett 1992: 252-253). He then suggests that the list can be reduced to two broad categories: group-oriented (those relating to the group at large); and individualistic (those relating to the specific individual alone) (Huggett 1995: 183).

Huggett initially used tests of association through bivariate tests for age and sex identifiers, using Atwell-Fletcher's simulation technique. Discriminate analysis was then used to analyse associations between age, sex, artefact types, orientation, and body position. This step classifies cases into groups based on those characteristics (Huggett 1995: 184). He then applied clustering based on artefacts, followed by factor analysis to make newly reduced artefact categories, and compared these results to the previous cluster results. Factor analysis was used here to reduce the number of artefact categories. The results illustrated that within the broader categories of age and sex, there is potential for further differentiation based on mortuary patterning (Huggett 1995: 184-189).

Lynne Goldstein (1981) advocates a classification scheme that studies the function and the context of groups though spatial patterning and object associations, which included monothetic-divisive cluster analysis. She used this 'substance-type multi-dimensional' (Goldstein 1981: 63) approach in her study of formal organised disposal areas in the Mississippian period Moss and Schild Cemeteries in the lower Illinois River valley in order to analyse the structure present and identify the various groups present (1981). Goldstein also comments on some of the problems with Tainter's (1975) approach of energy expenditure as well as the problems with early mortuary research, since the focus of those studies is the identification of individual status and social groupings (1981: 56). She follows by underlining the necessity of understanding and including the 'context' and then addressing the problem of how sites are selected for study and how the recovery of materials varies from site to site, time and objective.

One important factor that Chapman and Randsborg (1981) bring attention to are the areas that should be included in an analysis aside from the standard rank and status, such as environmental constraints on grave location (see, for example, Ucko 1969). They also point out the importance of cemeteries that are used over generations and the ever-changing behaviour towards burial in the same location and the overall impact that that has on what is recovered (Chapman and Randsborg 1981: 15).

### 4.2.3 The Application of Statistical Methods to Conflict Situations

As studies of mortuary behaviour tend to be concerned with formal analysis of cultural systems or studies of cultural contexts, the situational aspects of conflict burial behaviour may be difficult to identify. Some analysts using the monothetic-divisive approach, for example, focus on objects as primary indicators of status and this is problematic. Pader (1982), however, does provide an alternative to the status/rank approach in her analysis of Anglo-Saxon burials. Pader examined the ways in which particular burial elements might be actively used to symbolise certain social categories, such as age, sex, and rank. She focused on locational factors such as skeletal position, as well as the presence or absence of objects, and object location, using a similarity matrix (principal component analysis and Gower's coefficient) (Pader 1982: 86). The approach employed here is comparable to that proposed by Pader because it measures similarity of not only the type of artefacts and their location within the burial, but also body treatments.

Baxter (1994) comments on the possible problems with clustering methods when applied to burials and in the case of conflict burials when status and identity can be blurred, his comments may prove to be even more appropriate:

> In mortuary studies where different groups are characterised by the possession of attributes (i.e. grave goods) exclusive to their stratum, clear cluster separation seems to be expected. The possession of attributes that cross-cut strata, or reflect aspects of society other than status, clearly complicates matters, and may militate against the use of popular clustering techniques (Baxter 1994: 155).

Many of the studies of the patterning of burial remains and the identification of social distinctions applying the monothetic-divisive approach are effective when used to identify rank and status based on the presence or absence of attributes. In conflict situations, however, effort may be put into the hiding of graves, not the celebration of burial; therefore, traditional status indicators in burials may not be as relevant as variables in normative burials.

Since the identification of appropriate cluster configurations is problematic in conflict situations, alternative techniques were used on the data in this thesis in order to find a complementary structure that would support the identified structure (see also O'Shea 1984). Huggett (1995) further suggested that the "optimal cluster method should be identified independently of the other analyses in the study in order to increase confidence in any resulting structure" (Huggett 1995: 185). The data here were tested with average- (between-group) linkage method; and in addition to testing the entire dataset as a whole, the conflict data were also tested independently from the normative data. This method was applied to classify the burials into separate, clearly defined clusters that represent the variations in the types of burials because between-average linkage avoids the problems of extreme linkage produced by complete- and single-linkage methods (Baxter 1994: 158). Furthermore, between-average was used here because there is not a reversal of the level of dissimilarity after a certain step is reached which occurs in within-group average (Bacher 2002: 50).

In the present analysis, k-means clustering was chosen in addition to hierarchical clustering to identify patterns of behaviour because of its sensitivity to skewness (Baxter 1994: 156). This application of k-means may identify patterns or correlations that might otherwise not have been recognised in hierarchical clustering because of its iterative nature, thereby removing the multiple levels of grouping inherent in hierarchical clustering (Shennan 1988: 225) and avoiding possible unwarranted structure imposed by hierarchical techniques (Baxter 1994: 147).

In addition to similarities in focus to Pader's analysis (a contextual approach to the presence or absence of grave goods and locational factors) this research also takes an approach similar to Shepherd's (1999) in her analysis of Late Iron Age Finnish burials. While Shepherd did not include quantitative methods in her analysis, her approach towards qualitative comparisons of several Finnish cemeteries is similar to the comparisons of normative burials to contemporary conflict period burials applied in this study. The qualitative approach she applied was the result of contending with many of the same issues in data presented here, such as a number of researchers excavating and recording using different standards and purposes. This thesis does vary, however, by concentrating on the similarities within the data to create a database that may be tested with traditional quantitative methods as well as with the new statistical technique, neural networks, which also allows the use of qualitative variables. Hodson's (1990) analysis of the Ramsauer (Hallstatt) burials adopted this approach of integrating quantitative and qualitative attributes of burial data and applying multivariate techniques as a form of mathematical observation for the purpose of pattern recognition.

Shepherd states that she does "not accept that human behaviour can be systematically reduced to formulas such that one method analysis could apply to all sites falling into a set regarded as suitably typical and compatible with the formula"

(1999: 7). While this may be so, statistical methods can at least give an impression of what the burial context was, or suggest what it could have been. It is easy to say, like Goldstein, that quantitative approaches have "created a more complex version of an old problem" (1981: 56), or like Tainter, make the goal of mortuary studies the successful application of quantitative methods (1978). It may not be the methods that need to be restructured, however, but rather the questions we are asking of the data.

While the analysts above speak of examining the context of burial behaviour (see also Goldstein 1981; Hodder 1982b), the contexts they speak of are still primarily normative burial situations. Since the research in this thesis analyses a non-normative situation - 'conflict culture' - it is necessary to deviate from the normal approach of statistics toward the data, as well as the questions asked of the data. Conflict behaviour, considered in relation to the normal processes within most cultures, is aberrant behaviour, and so it is necessary to compare conflict period burials of a culture to contemporaneous normative burials of the same culture to identify standards of identification within cultures. Indeed, the goal of the analysis is to identify those responsible for burial by how the dead were treated, not the status of the dead as in previous studies (most notably Saxe (1970; 1971) and Binford (1971)). The following question is asked: Is there a standard of burial, cross-culturally during conflict that is identifiable? Likewise, what if the burial type is an expression of the social persona, not that of the dead as proposed by Saxe, but that of the individuals doing the burying? This is a point that is addressed by the more recent approaches to mortuary studies. Both Saxe/Binford and the contextual approach of Hodder look at the identity of the dead, not that of the burier and their status and their relationship with the dead. The burial is an active response to the identity of the dead and the living.

#### 4.2.4 A Contextual Approach to Conflict Burial Analysis

In view of the problems with traditional approaches discussed above, and following Goldstein's (1981) lead regarding the importance of context, and given what has been developed, the research presented here goes back to the lowest common denominator of information regarding the placement and positioning of remains and artefacts in the recording of graves. This is applied to a dataset that, for comparative purposes, is highly diverse and widely distributed in time, space, and culture, from cultural resource management excavations in Canada to human rights investigations in the Balkans. This is one of the unique and unusual aspects of the data used in this study.

Since the data used in this study do not follow the format for traditional testing methods, issues such as inappropriate structure imposed on the data by the testing procedures may have an even greater impact than it would otherwise. Baxter (1994) also raises the issue that monothetic-divisive clustering can lack robustness and has a problem with detecting detailed variation in datasets that indicate culture-, group- and situation-specific differences – the sort of detail needed to understand the behaviour at specific sites. As a result, this thesis departs from the traditional interest in the rank and status of the dead, and instead, implements a method that incorporates contextual information. It additionally focuses on the role of the agents of the burial (friendly, neutral, or hostile groups), using a conflict model that considers variation from normative burial behaviour in a culture as an indication of the specific burial situation.

A majority of current statistical approaches to studying mortuary remains focus on normative behaviours in a normative context. The following is a discussion of what clustering methods are used to distinguish patterns in conflict mortuary behaviour and, in conclusion, a justification for comparing the results of this traditional statistical approach with neural networks testing.

## 4.3 Statistical Methodology

The need to understand fundamental burial behaviour at individual sites, as discussed above, requires a departure from traditional concerns with the social identity of those interred. Unfortunately, the greater concern with, for example, indicators of rank and status, has rendered many existing datasets unusable for detailed behavioural study, because of the need for careful archaeological documentation of artefacts and features in the traditional three dimensions.

Consequently, while there exists a body of work relating to large mass graves (in excess of twenty individuals), the documentary evidence and records of some of these sites are inappropriate for the present study. For example, the Crow Creek site in South Dakota, USA, is a mass grave (in excess of 400 individuals) that is the result of inter-tribal conflict in the 15$^{th}$ century; however, the lack of sufficient recording in the field made research and reconstruction of the site and events quite difficult. Other large datasets are inaccessible because they are evidence in criminal cases (e.g. almost all conflict burials in the past few decades), while some are simply unpublished. Despite these problems, however, it is important that a methodology be produced to accommodate the smaller size datasets because they do exist and they do need to be studied. The data here represent actual situations; situations as they appear, which is not always ideal, and data can be convoluted and not in large quantities to satisfy traditional statistical techniques.

Given the variety of approaches to the disinterment of victims of conflict, one problem faced with data entry in this thesis was the variability of the datasets. The five sites, excavated at different times within the past twenty years, had different goals and different methodologies; there was no single procedure for excavation or recording and the analysts had different definitions, descriptions, and categorisations for the sites. As a result, it was necessary in the present analysis to create one standard for the variables.

The database needs to be a fully integrated system that allows manipulation of views and the sampling of a particular context or set of variables, as well as viewing the structural phases of a site or series of sites. A poorly designed database can still be useful if the data has been sufficiently recorded; however, if the data has not been recorded, the most efficient and effective database will be ineffective (Huggett 1992: 31).

Microsoft Access was used to store the data and SPSS was used for testing the data. SPSS had two applications here: 1) to reduce the number of variables to be used; and 2) to identify patterns and correlations among variables. MATLAB with the SOM-toolbox was used to: 1) explore the data for patterns among the data; and 2) as an alternative approach to be compared to traditional multivariate techniques (i.e. hierarchical cluster analysis and k-means analysis).

### 4.3.1 ACCESS DATABASE

The data stored in the database represent different types of conflict over five centuries, fought by different groups (social, political, and/or cultural) or nations in seven countries as well as eight datasets representing normative burial practices for the cultures and countries characterized by the conflict data. As a result of this diversity of sites and conflicts, the data are highly varied, thus producing a complex database (see Appendix B for Access data entry directions).

Since only a few datasets collected had complete three-dimensional data, descriptive locations were used in order to incorporate more types of burials and the database that could accommodate both quantitative and qualitative forms of data, was developed.

Four primary tables were used, created in Access, for testing: Remains, Artefacts, Cemetery, and Graves. The Remains table (see Figure 4.1) developed into the most complex table used, with 15 variables required to identify a set of remains. Several were common sense variables with logical responses, such as Sex (to represent biological sex (male, female, or unknown)), or Status (military or civilian). Others were locational, describing the location and positioning of individual bodies within the grave, and three additional variables described the forensic aspect of the remains: articulation, cause of death (to represent the manner of death), and mutilation. The Artefact table had four locational variables and two descriptive variables, while the Grave (see Figure 4.2) table had six variables to identify an individual grave (see Appendix E for final Access table listing; Appendix B for Access fields and entry values).

The database contains all the information regarding the sites. However, much of what is stored is beyond the scope of this research.

| Remain ID | TMB | RCL | Orient | Orient Range | Artic | State | Sex | Status | Contain | Arm Position | Head Position | General Position |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Top | Right | 360.0 | 8 | 4 | Skeletonized | Male | Military | None | Side | Face Right | Supine |
| 1134 | Top | Centre | 321.0 | 8 | 1 | Skeletonized | Male | Military | None | N/A | N/A | Un-patterned |
| 1151 | Bottom | Centre | 360.0 | 8 | 4 | Skeletonized | Male | Military | None | Above Head | Face Up | Prone |
| 1174 | Top | Left | 90.0 | 2 | 4 | Decomposed | Male | Military | None | Undetermined | Undetermined | Undetermined |
| 1176 | Bottom | Centre | 255.0 | 6 | 4 | Decomposed | Male | Military | None | Undetermined | Undetermined | Undetermined |
| 1191 | Top | Centre | 270.0 | 6 | 4 | Decomposed | Female | Civilian | None | Above Head | Face Left | Prone |
| 1194 | Middle | Left | 180.0 | 4 | 4 | Decomposed | Female | Civilian | None | Behind | Supine | Supine |
| 1215 | Top | Left | 270.0 | 6 | 4 | Skeletonized | Male | Military | None | In/On Front | Face Up | Supine |
| 1250 | Bottom | Centre | 1.0 | 1 | 4 | Skeletonized | Male | Civilian | None | Outstretched | Prone | Prone |

| Remain ID | Cause of Death | Mutilation | Commingling | Grave ID |
|---|---|---|---|---|
| 5 | SFT | Fracture | 2 | 2 |
| 1134 | Undetermined | Dismemberment | 0 | 17 |
| 1151 | Combat | None | 2 | 31 |
| 1174 | BFT | Fractures | 1 | 53 |
| 1176 | Combat | Fractures | 0 | 53 |
| 1191 | GSW | None | 4 | 72 |
| 1194 | GSW | None | 2 | 73 |
| 1215 | PFW | Fractures | 0 | 83 |
| 1250 | GSW | Fracture | 4 | 106 |

**Figure 4.1** Example of individual Access records for remains[1]

[1] see Appendix B for field and coded entry definitions

| Location ID | Grave ID | Obscuration | No. Ind | Length | Breadth | Depth | Cemetery Type |
|---|---|---|---|---|---|---|---|
| 2 | 2 | Vegetation | 38 | 6 | 3 | 2 | Temporary |
| 2 | 2 | Vegetation | 38 | 6 | 3 | 2 | Temporary |
| 3 | 17 | None | 1 | 2 | 2 | 0.1 | Temporary |
| 10 | 31 | Disturbance | 2 | 3 | 2 | 1 | Temporary |
| 16 | 53 | None | 8 | 8 | 4 | 0.5 | Temporary |
| 16 | 53 | None | 8 | 8 | 4 | 0.5 | Temporary |
| 20 | 72 | Woods | 2 | 2.03 | 1.5 | 1 | Temporary |
| 20 | 73 | Woods | 4 | 1.8 | 1.7 | 1 | Temporary |
| 19 | 83 | None | 3 | 2.55 | 1.7 | 0.35 | Temporary |
| 25 | 106 | Vegetation | 8 | 4.5 | 0.8 | 0.8 | Temporary |

**Figure 4.2** Example of individual Access records for the Grave Table

### 4.3.2. CODING

A coding system for the fields and entries from the original Access database had to be developed that would work in both SPSS and MATLAB. The burial attributes were reduced to a presence/absence (binary) format. The coding system for each record (Figures 4.3-4.5) was developed that incorporated the fields and entries from the original Access database that consisted of both binary and continuous values (see Appendices C and D for complete coding systems).

While the database may contain more comprehensive information regarding burial attributes, it was important that the data be transformed and reduced into a format that would be manageable by the statistical software. It was necessary to record the relevant attributes that would thoroughly and accurately represent not only the characteristics of the body, such as age, sex, and status, but also the context of the burial. Each record for a set of remains consisted of several categories, including grave and cemetery properties, body positioning, associated artefacts, and cause of death.

The attributes recorded for graves were: length, breadth, depth, and type (permanent or temporary grave). Cause of death originally consisted of 24 variations, which created unnecessary complexity to the database. Body positioning initially included descriptions of body placement, such as arm, head, and general body position, e.g.

outstretched, supine, prone, or flexed. This level of detail for body positioning and cause of death was reduced after the first round of testing described below. The reduction of these two definitive variables was performed because not only did the diversity of the causes of death and element positions not offer more information regarding burial behaviour, but the level of detail masked the general pattern of behaviour at the burial.

Coding associated artefacts become a complex situation because of the large variability of artefacts recorded and it was important to isolate the meaning, which is not always easy with highly symbolic items, of an artefact from the specificities. Different models of a particular item may be present, yet these variations may not have significance. For example, there were 11 different calibres of bullet represented in the database. These variations produced a bias towards a particular calibre, which proved to obscure the real significance of the artefact, which was the presence, or absence of a bullet in the burial. Another issue was defining the location of artefacts which proved to be difficult. Among the conflict burials, there was not one standard or rule defining a grave or treatment of the remains (such as orientation or layout). These issues emerged because of the range of periods (from 1461 to 1995), location of sites used, the different cultures and rituals present, and the variation in symbols of normative artefacts increased the diversity within the database, thereby making coding decisions a complex undertaking.

The coding for the neural networks developed out of the coding for the multivariate statistical testing. Where the entries for many of the variables for traditional statistics were initially nominal values, the variables were reduced to binary, presence/absence variables for the comparative multivariate statistics and neural networks testing.

| Remain ID | TMB | RCL | Orient Range | Artic | Sex | Status | Contain | Arm Position | Head Position | General Position | Cause of Death | Mutilation | Comming | Obscure | Cemetery Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1 | 1 | 8 | 4 | 1 | 1 | 1 | 1 | 4 | 3 | 5 | 5 | 2 | 5 | 1 |
| 1134 | 1 | 2 | 8 | 1 | 1 | 1 | 1 | 8 | 9 | 10 | 18 | 10 | 0 | 5 | 1 |
| 1151 | 3 | 2 | 8 | 4 | 1 | 1 | 1 | 4 | 6 | 2 | 1 | 0 | 2 | 1 | 1 |
| 1174 | 1 | 3 | 2 | 4 | 1 | 1 | 1 | 7 | 7 | 1 | 8 | 4 | 1 | 5 | 1 |
| 1176 | 3 | 2 | 6 | 4 | 1 | 1 | 1 | 7 | 7 | 1 | 1 | 5 | 0 | 5 | 1 |
| 1191 | 1 | 2 | 6 | 4 | 2 | 2 | 1 | 4 | 3 | 2 | 1 | 0 | 4 | 5 | 1 |
| 1194 | 2 | 3 | 4 | 4 | 2 | 2 | 1 | 3 | 1 | 3 | 1 | 0 | 2 | 5 | 1 |
| 1215 | 1 | 3 | 6 | 4 | 1 | 1 | 1 | 2 | 6 | 3 | 12 | 5 | 0 | 5 | 1 |
| 1250 | 3 | 2 | 1 | 4 | 1 | 2 | 1 | 5 | 2 | 2 | 1 | 5 | 4 | 5 | 1 |

**Figure 4.3** Example of individual SPSS (initial testing) records for remains (see Appendix C for field and entry definitions)

| Remain ID | Status | Contain | CoD-CR | CoD-EJ | CoD-SD | CoD-N | Mut | Comming | Marker | Cloth | GG | Body position | Misc artefact | Cem Type | Ob Intnt | Label |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | Towton |
| 1134 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | Custer |
| 1151 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Korea |
| 1174 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | Bosnia |
| 1176 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | Bosnia |
| 1191 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | Croatia |
| 1194 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | Croatia |
| 1215 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | Snake |
| 1250 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Spain |

**Figure 4.4** Example of individual SPSS records for remains (see Appendix C for field and entry definitions)

```
14
#n Status Contain CoDCR CoDEJ CoDSD CoDN Mut Mark Cloth GG BodPos Misc CemTyp ObInt
#1 site
0 0 1 0 0 0 1 1 0 0 1 0 0 0 Towton
0 0 1 0 0 0 1 0 1 0 0 0 1 0 Custer
0 0 1 0 0 0 0 1 0 0 0 0 0 0 Korea
0 0 0 0 0 1 1 1 1 0 1 0 1 0 Bosnia
0 0 1 0 0 0 1 1 1 0 1 0 1 0 Bosnia
1 0 0 1 0 0 0 1 1 0 1 0 0 0 Croatia
1 0 0 1 0 0 0 1 1 0 1 0 0 0 Croatia
0 0 1 0 0 0 1 0 1 0 0 0 1 0 Snake
1 0 0 1 0 0 1 1 1 0 0 0 0 0 Spain
```

**Figure 4.5** Example of MATLAB (for SOMtoolbox) records format

### 4.3.3 SPSS METHODOLOGY

All of the tables exported used a combination of ordinal and nominal variables. The ordinal variables are: Orientation, Articulation, Date, and grave dimensions (Length, Breadth, and Depth). There were also coded interval values, such as Age and Orientation range; however, the primary variables used in testing are nominal (See Appendix C for final variables and entries list).

The application of the multivariate techniques was to test the applicability of the traditional statistical methods to the burial model and to identify potential patterns in conflict mortuary behaviour. This testing would analyse the data that represent both normative burials and conflict burials, as well as the variables that define the two.

#### 4.3.3.1 Cluster Analyses

There are many examples of the use of cluster analysis in the study of mortuary behaviour (e.g. Shennan 1975; Tainter 1975; Pader 1982; O'Shea 1984; Hodson 1990; Huggett 1995; and Manly 1996). Cluster analysis, and other exploratory quantitative techniques, has had a turbulent history in archaeology, but if these methods are approached as tools to recognise patterns in the data, they can be useful in the overall analysis of burials, hence the application of such techniques in this research.

The type of data and the type of analyses dictated the methods to be used in testing the burial data. All of the variables of the qualitative data were coded into presence/absence format and the aim of the multivariate testing was not only identifying clusters based on common attributes, but also the relationships between attributes; therefore, a similarity coefficient was deemed the most suitable measure.

One issue with the data is the matter of co-absence. Gower's coefficient may be used when co-absence is thought to be indicative of similarity (Baxter 1994: 157). Pader (1982) and Huggett (1992) had similar issues of the matter of co-absence among the attributes used in their analyses; however, they disagreed about the meaning of co-absence. While Pader approached absence as meaningful, Huggett viewed that absence should not be indicative of similarity. Furthermore, Huggett (1992: 96) cited that absence may occur for reasons other than cultural, such as natural decomposition, and as such, one can not identify with certainty the cause of absence (Aldenderfer and Blashfield 1984: 29, cited by Huggett 1992: 96). This difference in view on co-absence is illustrated in the coefficients chosen; the Gower coefficient was used by Pader (1982) to calculate similarity, whereas Huggett (1992) used Jaccard's coefficient for his analysis.

Associations can be illustrated by a 2 x 2 table showing attribute possession, which can help explain the two coefficients.

| | + | - |
|---|---|---|
| + | a | b |
| - | c | d |

The Gower coefficient (G) is defined as:

$$G=\frac{(a+d)}{(a+b+c+d)}$$

Whereas the Jaccard coefficient (J) is:

$$J=\frac{a}{(a+b+c)}$$

Importantly, with Jaccard's coefficient, co-absence is not considered to suggest similarity (Baxter 1994: 157), which can be an important point since absence in an archaeological setting may have different causes, as such, it is a preferred measure of similarity (Aldenderfer and Blashfield 1984: 29). Additionally, since the dataset has several variables that occur rarely, the Jaccard coefficient is preferable because the case would have only a small portion of the total range (Shennan 1988: 204). Furthermore, the Gower and Jaccard's coefficients provide similar results for binary data (Aldenderfer and Blashfield 1984: 31); as a result, Jaccard's coefficient was the method chosen to measure similarity.

Since similarity, not distance, was the measurement used, average- (between-group) linkage was set as the clustering method, instead of Ward's method, which applies a distance measurement; furthermore, average-linkage performs better in total coverage (Aldenderfer 1982: 60). Average- (between-group) linkage was selected because it also avoids chaining and dilation (Everitt 1980: 26) and single- and complete-linkages use too extreme definitions of cluster homogeneity; in that a candidate must have a level of similarity to just one of the members (single-linkage) or, in the case of complete-linkage, to all the members of a cluster (Aldenderfer and Blashfield 1984: 39-40). Moreover, complete-linkage produces small, compact and spherical clusters that may be completely irrelevant to one another, and are merely a product of the method's attempt to reduce the number of factors involved (Baxter 1994: 155). What is more, average-linkage performs better than complete-linkage in the presence of outliers (Aldenderfer 1982: 61) and considering the context of the data, a large number of outliers are quite likely. Initial testing here demonstrated that Jaccard's coefficient and average-linkage produced the most promising, well-structured clusters of similar cases.

For hierarchical clustering, factor analysis was applied as a validation method in order to evaluate the clustering results and identify the most adequate solution (Aldenderfer 1982: 68-69; Shennan 1988: 228-231). It is important to note that the different validation methods may produce different results. This does not automatically indicate that there is not any 'real patterning'; it could mean that one method recognises the pattern while the other validation method does not (Shennan 1988: 229-230.)

#### 4.3.3.2 Factor Analyses

Doran and Hodson (1975) do not have a favourable opinion of factor analysis, questioning the relevance of separating common and specific variance. They favour Principal Components Analysis (PCA) because it 'has clear aims and it produces a unique result for a given body of empirical data' (Doran and Hodson 1975: 197). This seems a harsh criticism for a method that, while it may not offer all the answers, can offer insight to the relationships between variables when viewed from the perspective that one method of analysis cannot provide all the answers. Furthermore, it can suggest which variables create the most variance within a dataset. Consequently, factor analysis was used in this analysis in order to examine correlations between variables within the dataset as a whole, within conflict only data, and at the individual site level. At times, some variables were removed at the individual site level because there were less than two occurrences of a particular variable.

For factor analysis, the coefficients correlation matrix was used because the total variance will be equal to the number of variables used in the analysis (Shennan 1988: 271-272); additionally, this choice was based on the decision to make all of the variables of equal importance (Everitt and Dunn 1983: 42). Furthermore, principal components analysis was applied as the method of factor extraction in order to integrate correlated variables into one factor that would explain most of the variation in the fewest number of variables.

The factor extraction was set to an Eigenvalue of 1 in order to maximize the value of the variable factors; otherwise the extracted factor will have a value less than any of the variables (Everitt and Dunn 1991: 244). After initial testing of the entire dataset, set to extract seven factors, a scree plot was produced to identify the point were the Eigenvalues levelled off (Everitt and Dunn 1991: 247). The result of the scree plot was that five factors had Eigenvalues of one or more; therefore, it seemed that for this research an Eigenvalue of 1 was appropriate for all subsequent testing; furthermore, the five factors can also represent five possible burial types (normative, friendly, neutral, hostile, and unknown). Using different values of factors with rotation allowed the identification of the best structure of factors to the data.

Even though oblique rotation can be considered a more natural shape, varimax rotation was applied to maximize the data so that the pattern of loadings on each factor was as diverse as possible. This method of rotation minimizes the number of variables which have high loadings on any one given factor. It also creates factors comprised of a few large loadings and as many near-zero loadings as possible (Everitt and Dunn 1991: 251). Since each factor will tend to have either large or small loadings of particular variables, a varimax rotation yields results which make it easier to identify each variable with a single factor. Since the range of variables had to be reduced significantly to be manageable in the software, it was necessary to maximize the remaining variables.

There are different opinions on the size of the loadings to interpret. One 'rule of thumb' is to accept loadings that exceed 0.3 (Baxter 1994: 68; Child 1970: 45). While there have been more stringent methods of determining an appropriate level to accept (e.g. Huggett 1992, 1995), following the lead of Baxter (1994) and Child (1970) it appeared that for practical use loadings greater than 0.3 would be statistically meaningful for this analysis.

Not only will factor analysis be used to identify patterns and structure in the data, but the factor scores for each case will be tested using hierarchical analysis. Furthermore, the clustering of factor scores will ideally cluster the data based on the latent variables represented by the factors (Baxter 1994: 169). The goal of this is to identify a methodology that will best separate burials based on the conflict model. O'Shea (1984) applied this technique to data from the Larson site; however, analysis illustrated a lack of structure in the results. Huggett (1992) had similar poor results from the clustering of factor scores in his study of Anglo-Saxon burials.

#### 4.3.3.3 K-means clustering

The k-means testing used the same variables that both factor and cluster analyses used. K-means clustering was also selected as an alternative to hierarchical clustering results because it used a distance measure rather than a similarity coefficient, as used in the hierarchical clustering. This different method of measurement will offer an alternative clustering method to the hierarchical method and will work as a point of comparison for the different measurement methods. In addition, k-means analysis works directly with the data – the clusters are comprised of the data, not a derived similarity matrix. Hodson (1970) uses k-means, in addition to hierarchical clustering, in his comparison of techniques clustering fibulae from the Iron Age La Tène cemetery of Münsingen (described in Hodson, Sneath and Doran 1966; and Hodson 1969).

For the k-means testing, Euclidean distance was used on the data because of its capacity to give greater emphasis to larger differences between variables. One issue was determining the number of clusters to be derived. This decision was approached heuristically, based on the conflict burial model. At the individual site level, three clusters were selected to be created, one to represent each burial type of the model (friendly, neutral, and hostile); consequently, with all conflict and all normative data, four clusters were extracted to represent the three burial types of the model, and one normative burial type.

However, because *a priori* assumptions are made in the form of the desired number of clusters produced, the method will produce clusters even if there are not clusters in the data. Furthermore, k-means analysis can create an unrepresentative structure of the data because of this issue. Nevertheless, k-means is applied in this study in order to identify the statistical method that most effectively and accurately recognises the different burial types.

### 4.3.4 DISCUSSION

After the development of a burial model identifying three types of conflict burials (friendly, neutral, and hostile) and normative burials, the data were tested using the multivariate techniques introduced above.

The various methods applied to the data may produce comparable results, but the degree of similarity will vary. Such differences may be caused by the nature of the method itself, or by one or more of the subjective decisions made by the researcher, such as the number of clusters retrieved, sample size, or the choice of rotation. While this variation may appear to affect the overall performance, objectivity, or reliability of the results, the different perspectives offered are informative in themselves – they allow one to approach the data from a different position and ask different questions.

The multivariate techniques applied here were used to explore the data and suggest patterns and relationships among the variables. Furthermore, they indicated which attributes of conflict burials most clearly define burial types within the model. Most importantly, these statistical results act as a guide, assisting in the study of behavioural aspects of conflict burials as manifested in the material and symbolic evidence available within the burial context.

Mortuary behaviour is a dynamic social domain, which is made more complex during conflict situations. Traditional multivariate techniques have a coarse resolution based on linear processing which may not extract all the information from non-linear data. Since variation in intent in conflict burials is so important to interpretation, what is needed is a more flexible method that allows the addition of more qualitative data and has the potential to offer a new perspective on the data. In this thesis, a neural network approach is presented as a novel non-linear application to burial analysis that may enhance understanding of conflict mortuary behaviour.

## 4.4 Neural Networks

Neural Networks or Artificial Neural Networks are methods of analysing data inspired by the nervous system of the brain, in that the process learns by example (training) and then applies this experience to recognise patterns in new data. The system mimics the basic structure of brain processing through its network of interconnected processing elements (neurons) and layers. The unique structure of the processing units within the neural network connects the units in such a way that every input is locally processed among neighbouring units, which allows for a non-linear processing of the data. Neural networks can therefore be used to recognise patterns or classify data, as well as generate predictions. In addition, neural networks can be useful for analysing multi-dimensional data without *a priori* assumptions similar to those made in k-means clustering (Garson 1998: 82). The characteristics of neural networks are discussed in more detail by a number of authors, including Gurney (1997), Callan (1999), Haykin (1999), and, for the application of neural networks in the social sciences, see Garson (1998).

Neural networks can be an effective tool for analysing and classifying the fuzzy data typical of archaeology because of their non-linear approach to analysis and their ability to process qualitative information. There are few applications of neural networks in archaeology and even fewer deal with mortuary analysis, see Bell and Jantz (2000) and Davino et al. (1999). This thesis therefore represents a novel approach within this field of study.

The way that neural networks deal with non-linearity is an important aspect of its utility in archaeology, as the pattern of relationships affecting mortuary behaviour – and indeed, any human behaviour – is not linear; therefore, this approach has a great potential to enable new insights into archaeological phenomena.

There are two general types of neural networks: supervised and unsupervised. A supervised model includes data to train the neural network and another set of data to test the network. Conversely, an unsupervised neural network classifies the data without the desired results being programmed into the model.

### 4.4.1 Multilayer-Perceptron Neural Networks

Although there are different variations of neural network models within the broader type of supervised or unsupervised neural networks, the most commonly applied model in archaeology is the multilayer-perceptrons (MLP) back-propagation neural network introduced by Rumelhart et al. (1986). This type of neural network is a supervised model that classifies data based on training data and examples of desired output. The model uses basically three layers: an input layer, a hidden layer (where the network processes and interprets the data forward and backward until the model is trained), and the output layer (Figure 4.6).

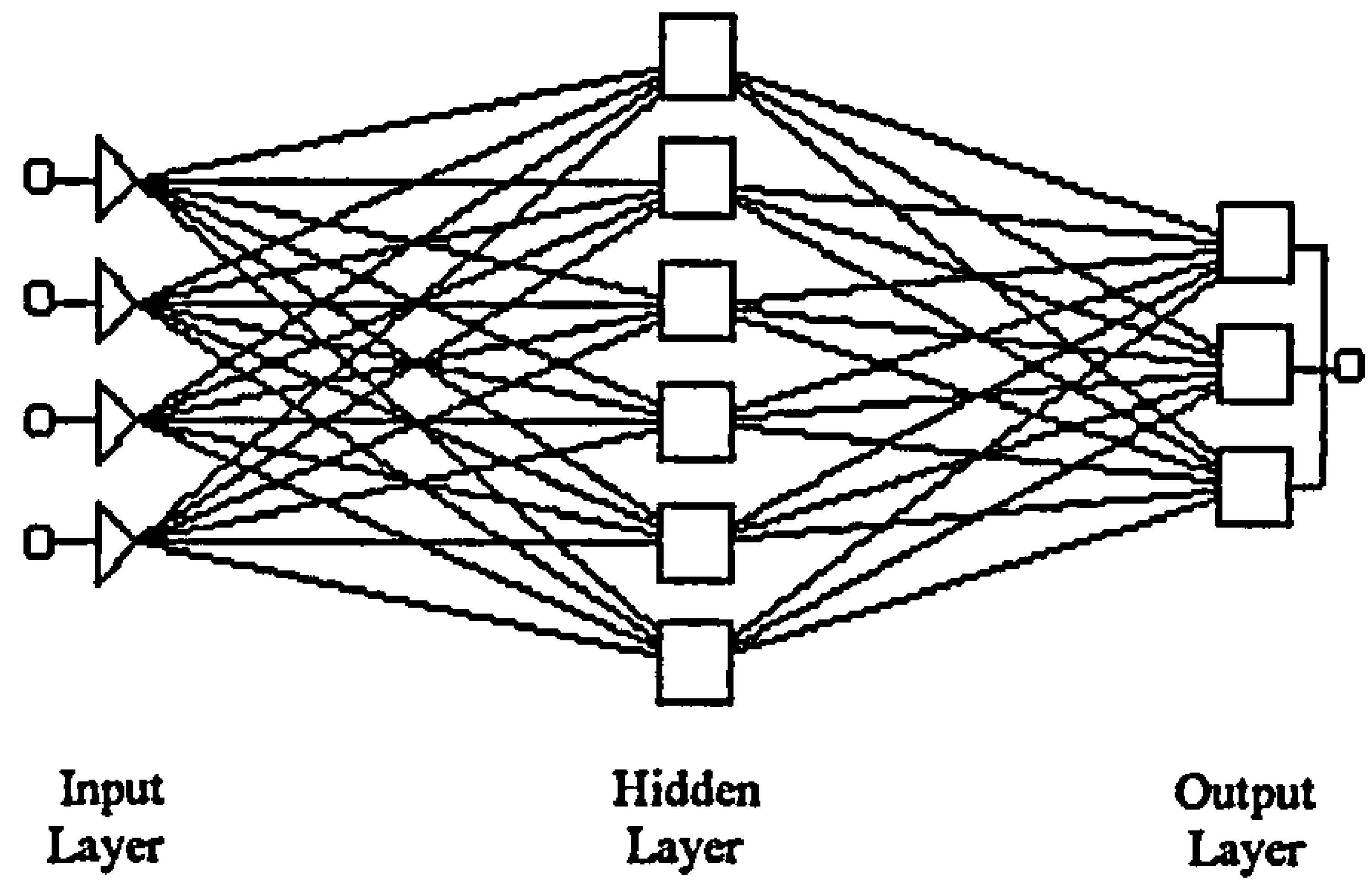


**Figure 4.6** Model of a Multilayer-Perceptron neural network (Statistica 2003)

The behaviour of the output units depends on the activity of the hidden units and the weights between the hidden and output units. After the neural network is trained effectively, the model can then be used to classify (or predict) new data based on what it learned from the training data.

Multilayer-perceptrons identify patterns or trends in data; they are therefore well suited for prediction or forecasting needs and are applicable in different areas and applications in, for example medicine, the stock market, and engineering (such as correctly detecting welding flaws (Liao et al. 2003)). There are many applications in the social sciences as well. Multilayer-perceptron back-propagation has been employed in several examples of conflict studies by testing hypotheses that attempt to predict conflict based on historical precedents (Cerrito 1996) or the causes of conflict (Williams and Karasik 1994) from a set of social variables, e.g. democracy, economic interdependence, international organisations, and alliances. More recently, Lagazio and Russett (2004) used the MLP back-propagation method for predicting and explaining interstate conflict. The study used eight social and economic dyadic influences on militarized and non-militarized disputes between 1885-1992 based on pre-cold war (1885-1945) era versus cold war and immediate post-cold war period (1946-1992) data. Their model correctly recognised 82.4% and 64.8% of cold war era and pre-cold war era military disputes respectively; it also correctly predicted 72.2% and 65.5% of cold war and pre-cold war era non-military disputes respectively. This is an example of mixed predictive power from the back-propagation algorithm.

The application of the MLP back-propagation neural network within archaeology has had mixed results. Juan Barcelo is one of the first archaeologists to apply neural networks to archaeology. He tested the method in a series of studies, such as classifying Iberian Bronze Age stelae (Barcelo 1995), pottery brittleness (Barcelo 1996), and pottery chronology (Barcelo and Faura 1997). The results of these three studies had poor predictive power – for example, the neural network developed for classifying stelae had low rates of correct classification with regards to region, based on the number of imported items and chronology of the stelae (Barcelo 1995: 172). Barcelo and Pijoan-Lopez (2004) had somewhat better results when they applied the MLP back-propagation method to lithic use-wear analysis to discriminate between types of uses and their residual wear patterns. Using ten images from six tools, they took 18 inputs based on macro and microscopic characteristics of the lithic surface. Training produced 75.46% and 58.3% correct longitudinal and correct transversal classification respectively. However, the results from the test data had lower correct classification rates: 68.59% and 54.23% correct longitudinal and correct transversal classification respectively (Barcelo and Pijoan-Lopez 2004: 429). The authors suggested that the low rates of correct classification could be based on the differences in variations in the images and the type of photography used and not on the use-wear patterns of the lithic materials. While some of the results may be mixed at this time, Barcelo is breaking ground in the application of quantitative analysis in archaeology by exploring new methods in applying neural networks.

Bell and Croson (1998) used an MLP back-propagation model to classify the geographic source of slag inclusions in iron bars from data sets originally published in Hedges and Salter (1979). The results of the neural network based on 16 chemical variables were used in conjunction with the results using principal components analysis (PCA). Their results indicated that neural networks working with other methods were a viable alternative to analysing data where other techniques might fail.

There are also several instances of the use of neural networks with Geographic Information Systems (GIS) data. Bescoby et al. (2003) integrated the two tools to create a system that would automatically interpret geographic data from archaeological sites. Clair Reeler (1997) integrated neural networks with GIS data consisting of total site area and features areas as a classification tool. She applied an MLP back-propagation using 20 variables from excavation reports and digitised maps that defined each site, for classifying Maori Pa (defensive sites) in New Zealand into site types. The neural network had a correct classification rate of 70% when the system was set to distinguish five clusters. This rate decreased to 48% correct classifications for 11 clusters. The analysis offered insight on influential variables regarding site selection as well as issues regarding surveying and recording these sites in the future. Another application for neural networks with GIS data is site location prediction. Analysing settlement patterns for the Neolithic to Iron Age European lowlands, Ducke (2003) created a neural network based on spatial variables such as terrain, distance to water, soil texture, and surface water. The neural network's analysis of the GIS data had 75-85% of the validation data correctly predicted based on the 'geo-archaeological' data (2003: 272). These results were a slight increase on the prediction threshold results of Reeler (1997), Barcelo (1995, 1996), and Barcelo and Pijoan-Lopez (2004).

Suzanne Bell and Richard Jantz applied a MLP back-propagation model to classify skeletal remains (from the Middle Missouri region of South Dakota, 1600-1817) to identify time-frame, phase, and location (east or west bank of river) based on osteological measurements. The authors indicated that at the 75% threshold, the prediction rate for time-frame was not high; however, at the 60% threshold, geographic location predictive power was better than chance (Bell and Jantz 2000: 207). The overall prediction rates at the 60% threshold for time-frame, phase, and bank location were 55%, 60%, and 70% respectively. They concluded from the results that the river provided an effective barrier, hence the patterns in time-frame and phase membership.

A second example of the application of neural networks to mortuary analysis is the work of Davino et al. (1999). A three stage testing approach was used to analyse 173 graves from the Iron Age cemetery at Sala Consilina, Italy. Their analysis included Multiple Correspondence Analysis, cluster analysis (using Ward's method) and an MLP. The aim was to recognise patterns of behaviour in the treatment of gender and age based on nine variables: Grave goods (type, material, preservation, location of production, and quantity), gender/age, preservation of burial, and burial dimensions. There were mixed results regarding correct classification and predictive power in all three methods applied. The authors concluded that neural networks analysis can supplement an analysis strategy that might otherwise discard elements, and suggested that applying a single methodology could not only be insufficient, but also misleading (Davino et al. 1999: 128).

In some respects, the results of the preceding studies applying neural networks to analyse archaeological data have not proved to be as successful as more traditional statistical techniques. On the other hand, these same results provide the groundwork for present and future analysis and understanding of non-linear archaeological data.

### 4.4.2 Self-Organizing Maps

Another type of neural network is the Self-Organizing Map (SOM) (Kohonen 1995; 2001). The SOM's learning process is competitive and unsupervised, which means that there is no additional input other than the data to be analysed to define a desired output. Unlike the multilayer-perceptron, which uses three or more layers, the SOM consists of two layers: an input layer and output layer (Figure 4.7).

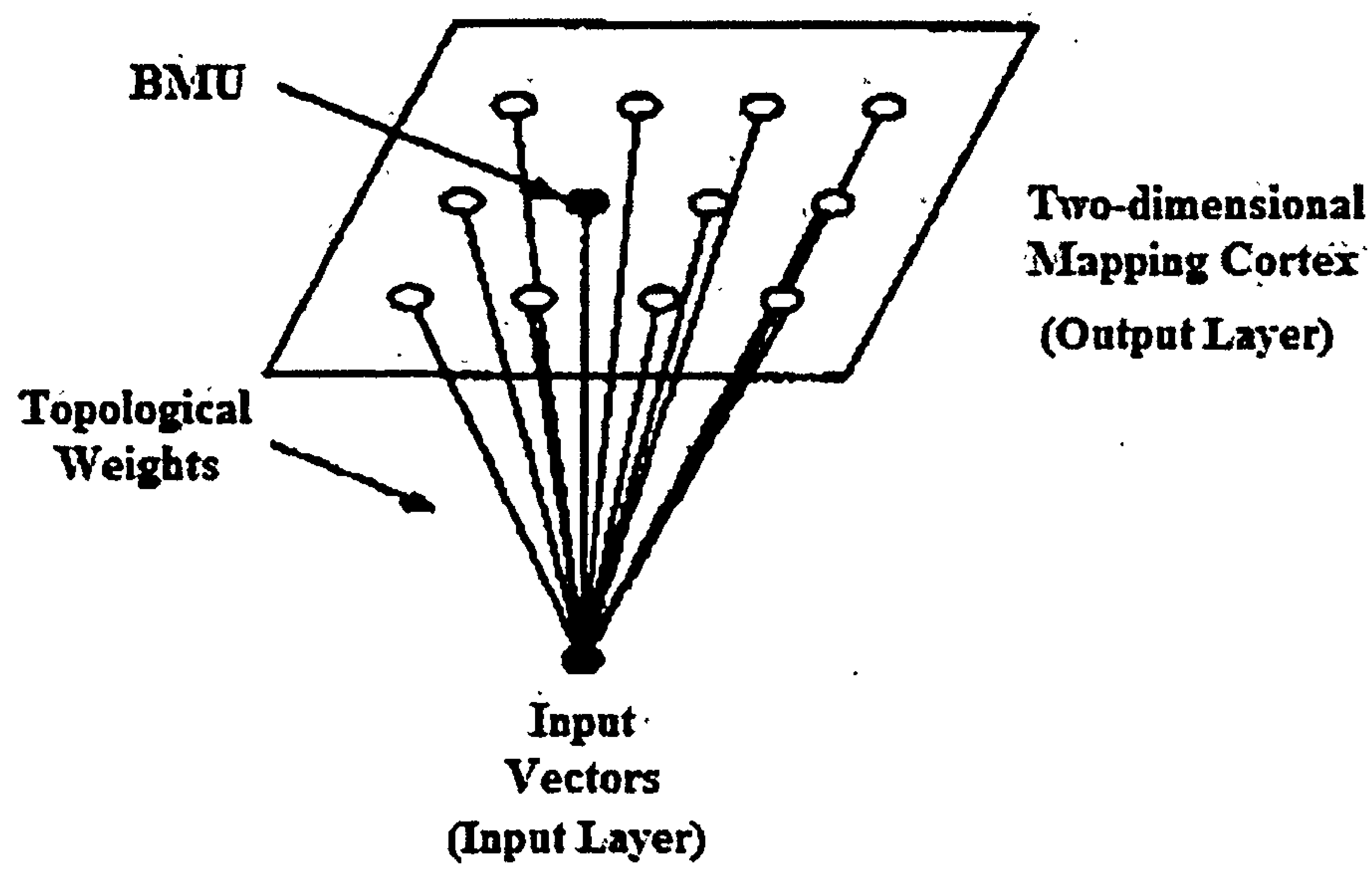


**Figure 4.7** Model of Self-Organizing Map neural network (Kohonen 2001)

The input layer has a number of vectors (neurons) equal to the total number of input features. The output layer, or map, is usually a two-dimensional regular grid of nodes defined by *n*-input data. Every node is characterised by an *n*-dimensional topological weight vector. One important characteristic of the competitive SOM learning process is that the learning algorithm takes into account not only a specific output neuron but also the neighbourhood of that neuron, thereby adjusting the weights associated with these neighbouring neurons. Consequently, the output neurons that are close to each other in the map will have similar characteristics.

The first step of the SOM is linear initialisation (or learning). Each new input neuron is given a location on the map; it is automatically classified or categorised. The SOM algorithm uses the minimum Euclidean distance to find the winning unit (the best-matching unit, BMU, which consists of the highest number of variables present) of all the SOM units (Figure 4.8). This learning stage is repeated until there is no change in the weight vectors (Kaski 1997: 21). In this version of a neural network, only one map node (winner) at a time is activated, corresponding to each input. There is also a 'batch' algorithm, so instead of using single records at a time, the entire dataset is presented to the map before adjustments are made (Vesanto et al. 2000). The locations of the responses tend to become ordered during the learning process. This is followed by a step that adapts all the input weights within the neighbourhood. Thus, neurons are modified and the output neurons that have similar characteristics stay close to each other on the resulting map created by the network (Kohonen 2001: 139). The processing algorithm of the SOM is similar to the k-means clustering algorithm. The difference is that in the SOM the distance of each input from all of the reference neurons is taken into account instead of just the closest neuron.

The resulting map illustrates the topological and metric relationships of the original data and the clusters inherently in the data. These illustrations can be used as tools for gaining insight into a data set. They can also be used to summarize data sets, together with the results of explorative research.

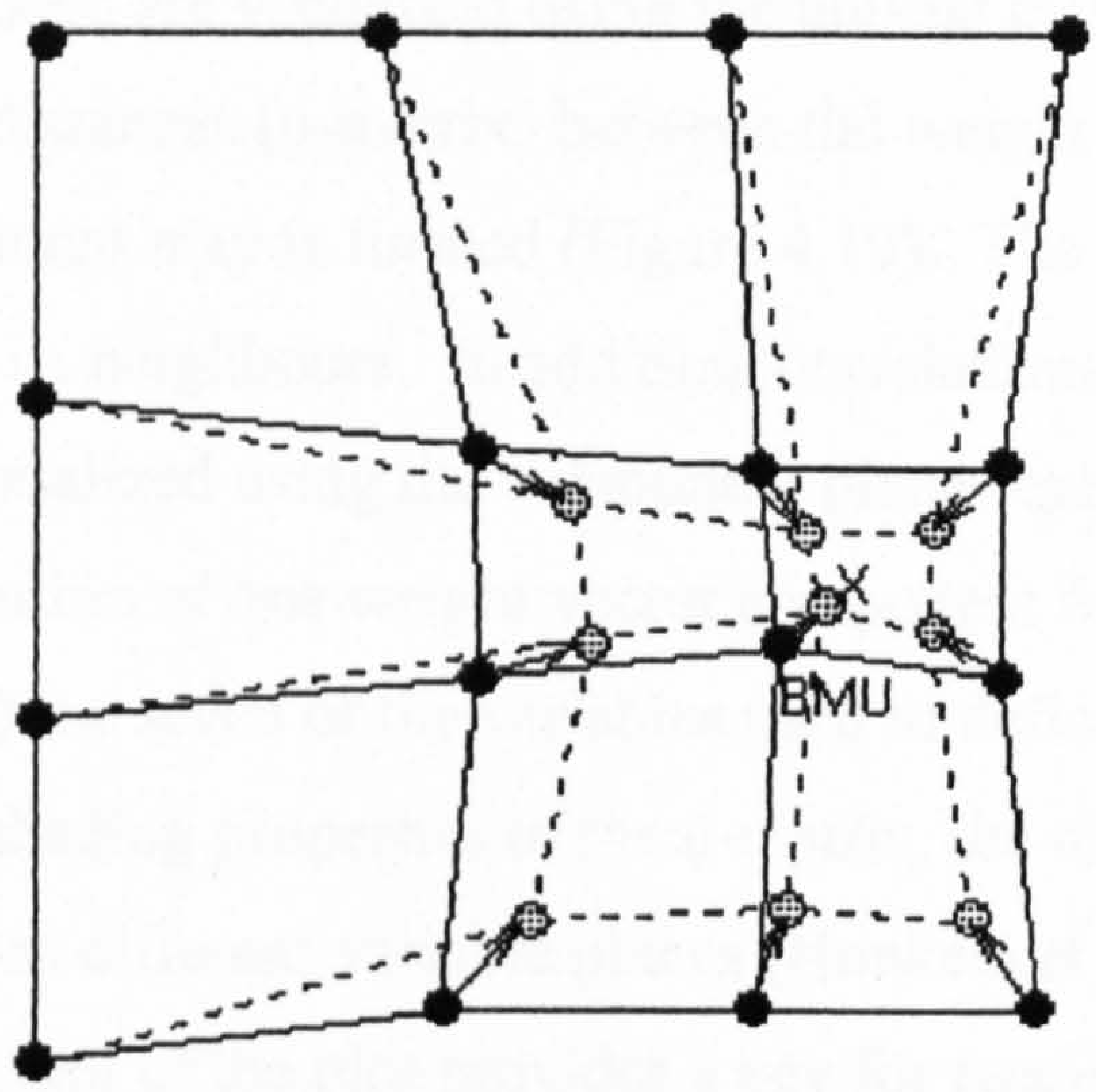


**Figure 4.8** Updating the best matching unit (BMU) and its neighbours towards the input sample marked with **x**. The black and grey circles illustrate before and after updating, respectively. The lines illustrate neighbourhood relations (Vesanto 2000: 18).

The SOM can be used in facilitating exploration of a data set, searching for known kinds of data, filtering of new incoming data, as well as visualization of the results. Furthermore, the MLP back-propagation method is a supervised process where, with some software, the user defines the number of clusters and the desired output, whereas the SOM is an unsupervised competitive method that itself defines membership, not relying on the user. It should therefore not be judged under the same criteria regarding success rates.

Another aspect of the SOM is the display of the results. The classic hexagonal lattice map (instead of the rectangular grid) is selected – so all six neighbours of a neuron have the same distance from the BMU (Figure 4.9).

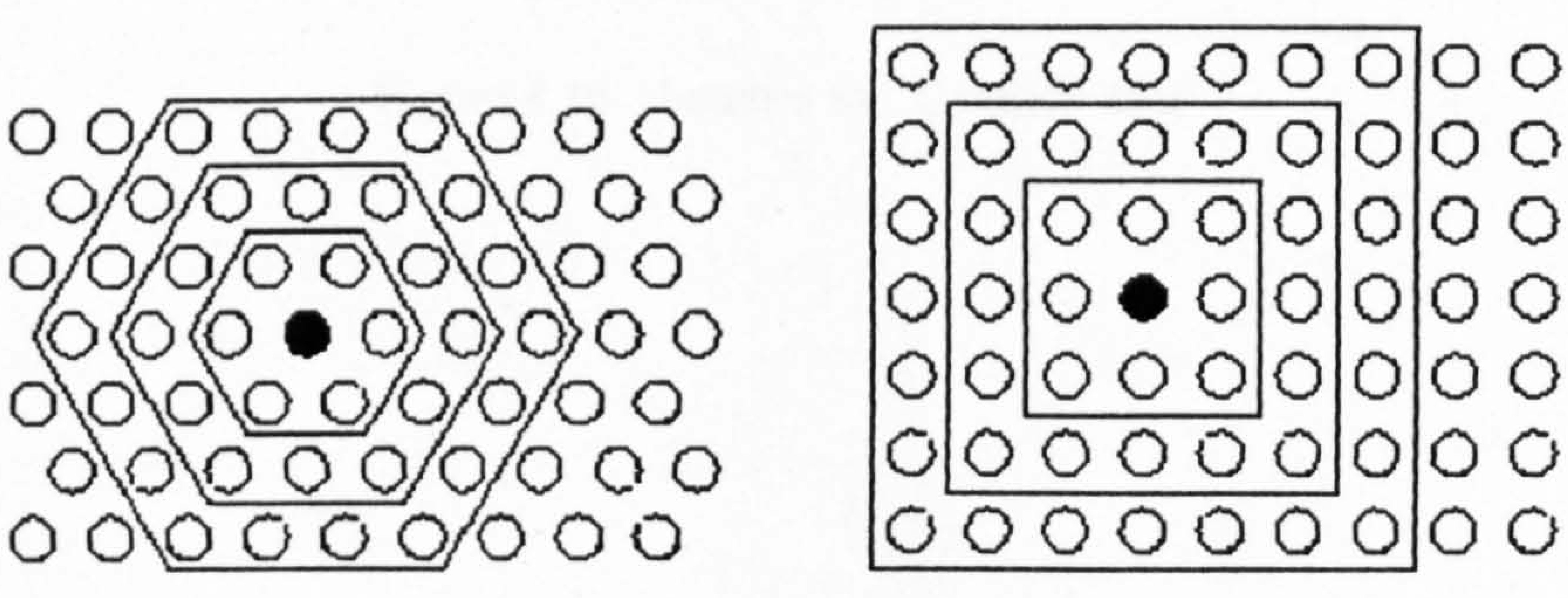


**Figure 4.9** Examples of hexagonal (a) and rectangular (b) lattice maps (Kohonen 2001)

Clusters that are produced are visualized using the unified distance matrix (u-matrix). A matrix of distances (u-matrix) between the weight vectors of adjacent units of a two-dimensional map is formed (Figure 4.10). The lighter the colour of a unit, the closer it is to its neighbours. In addition, correlations between vector components can be visualized using the component plane representation. Figure 4.11 shows the distribution of one weight vector component for each variable plane (one for each variable) for seven of the variables used to define the burials in this study. Similar to the shading properties of the u-matrix, the distributions illustrate the correlations between different variable planes (Honkela et al. 2000: 141). Also, the vertical bar to the right of the plot provides a key for reading the distances between the nodes (Laine 2003: 20). In addition, the scores displayed with the vertical bar are similar in nature to Principal Component Scores for each variable. For example, the bottom left corner of 'Cloth' component plane is dark – a high value. Similarly, 'GG' [Grave Goods] is light, which corresponds to a low value for the variable.

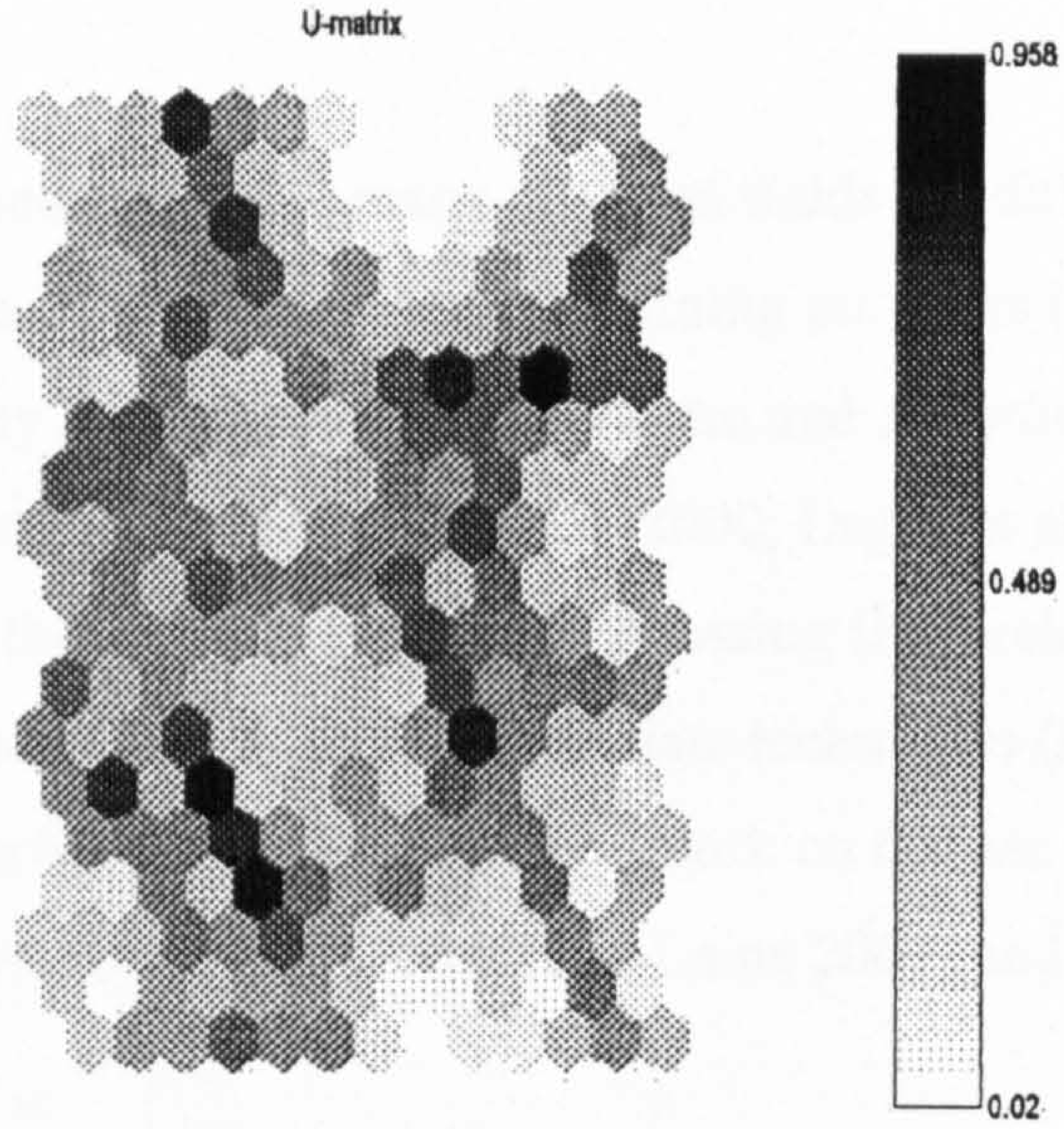


**Figure 4.10** U-matrix for 'Conflict' data

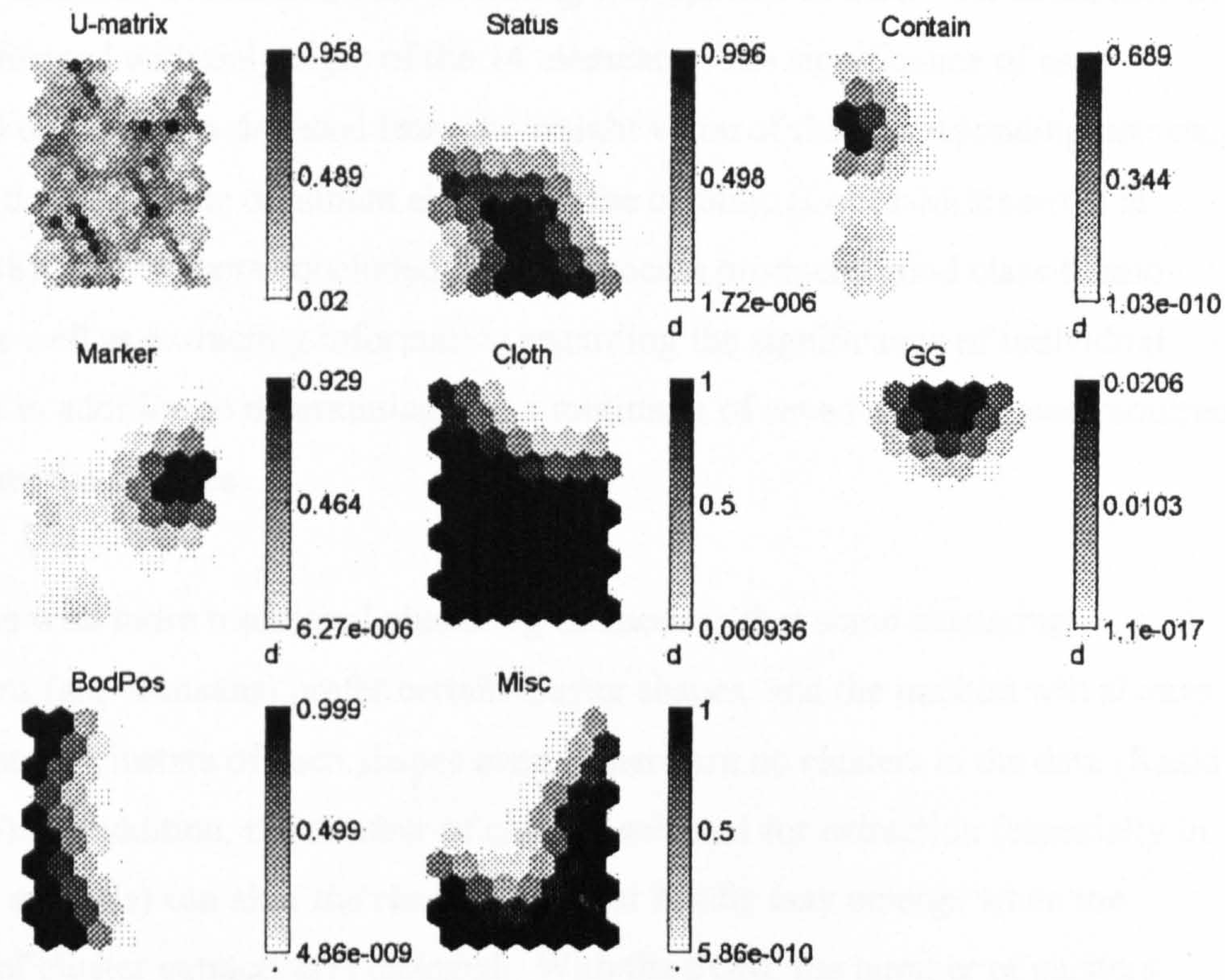

**Figure 4.11** Component planes distribution for 'Conflict' Data

The SOM approach has been applied to many different fields for different goals. There are several examples of SOM used for data-mining purposes (for example, Cottrell, Ibbou and Letrémy 2004; Kaski 1997; Vesanto and Alhoniemi 2000), data-mining applied to web based items (Kohonen et al. 2000; Lagus et al. 1998; Lagus 2002; and Vesanto 2000), the study of language processing (Honkela 1997), as well as clustering and comparison to traditional multivariate techniques (Kiang 2001; and Wu and Chow 2003). There is also a large body of work on the use of SOM in forest/paper industry analysis (e.g. Alhoniemi 2002 Laine 2003; and Simula et al. 1998; 1999).

Currently, there are few published examples of the implementation of SOM in archaeology. One example is the classification of Roman glazed ceramics (Lopez-Molinero et al. 2000). The chemical compositions (consisting of 14 elements per sample) and provenance of 68 sample ceramics were processed and classified by the SOM. The SOM defined two distinct clusters separating Calcareous bodies versus Non-Calcareous bodies. A third cluster was also formed, but it has a wide dispersion of ceramics - all the remaining ceramics that did not fit in either of the first two clusters. A second series of testing was applied to assess the suitability of clusters formed with only eight of the 14 elements. The significance of each chemical element was deduced from the weight value of the corresponding neuron, thereby identifying the dominant element in the ceramic (Lopez-Molinero et al. 2000: 588). The authors concluded that the process produced good classification results as well as extracting information regarding the significance of individual elements in addition to determining that a minimum of seven elements was required to separate the samples.

One issue with more traditional clustering methods is that some clustering algorithms (e.g. k-means) prefer certain cluster shapes, and the method will always assign data to clusters of such shapes even if there are no clusters in the data (Kaski 1997: 26). In addition, the number of clusters selected for extraction (especially in k-means analysis) can alter the results; different results may emerge when the number of cluster extraction is changed. With the SOM, the number of clusters extracted is determined by the method, not by the user.

Another important issue is that principal components analysis (PCA) cannot take into account nonlinear structures, structures consisting of arbitrarily shaped clusters, since it describes the data in terms of a linear subspace (Kaski 1997: 15), so while some of the scores may resemble the structure of PCA the results are non-linear in nature. As a result, linear projections of highly non-linear data results may distort or give a false perspective of the data.

These differences explain some of the reasons for the application of neural networks to the fuzzy, non-linear burial data in this study. Attention is paid to how the results from the neural network testing compare to the results from the more traditional multivariate statistical techniques. Finally, the goal is to discover a methodology, or combinations of methods, that will most accurately separate and identify conflict mortuary behaviour.

### 4.4.3 Neural Networks Methodology

Since the SOM method does not require supervision, it is used here because no assumptions about the distribution of the data are made. Another important aspect of the SOM is that significant information about the input variables can be obtained, such as the role and influence of each variable in clustering cases. In addition to these properties of the SOM, it is an effective method for displaying and retrieving data in a two-dimensional display. The SOM method is appealing because it provides easier to interpret results (because of the advances in visualisation). Despite the higher level of use of the MLP in archaeology, the successful prediction rates in previous archaeological applications were deemed to be too low for use here.

The platform used is MATLAB ver. 6.5 with the SOM toolbox add-on. The vital component of the SOM toolbox is the visualisation toolkit prepared in MATLAB (Vesanto et al. 2000: 5). It is a menu-driven program (see Appendix G for commands used) that includes a number of data analysis and visualisation tools. The toolbox was developed by the Helsinki University of Technology in order to create an easier method to implement the SOM algorithm within MATLAB. The toolbox can be used to pre-process the data, initialise, 'self'-train, and visualise the SOM as well as analyse the properties of the SOM and correlations between variables (Vesanto et al. 2000: 1).

The data was coded into a format that the toolbox would be able to process (see Appendix D). The neural network contained between seven and 14 variables in presence/absence (1,0) format; some variables were removed at the individual site level when there was no variance. In addition to testing the cases and their relation to the variables, the variables were tested for relationships between variables. The SOM method was used to create clusters of the data and to examine correlations between variables within the dataset as a whole, conflict only data, and at the individual site level. The number of neurons (inputs) was the same as entered in the hierarchical and k-means clustering and factor analysis.

There is very little written on the most effective and significant parameters for the SOM, and even fewer for archaeological applications. As a result, the software default settings were used here, such as Euclidean distance being used as the distance measurement to identify the Best-Matching Unit (BMU) for the first step of the initialisation process. Other default parameters used are linear initialisation and the 'Batch' training algorithm. These defaults process (or initialise) the data and then 'self'-train the data. After examination of the other methods of initialisation and training, the default settings were also deemed the most appropriate for the data used here.

### 4.4.4 DISCUSSION

The application in this thesis differs in some respects from the approaches cited above. While a majority of the archaeological applications of neural networks incorporate quantitative data, (Barcelo and Pijoan-Lopez 2004; Bell and Croson 1998; Bell and Jantz 2002; Reeler 1997) the neural network applied here analyses qualitative, fuzzy data. Neural networks are able to derive meaning from fuzzy data in a non-linear manner, which extracts patterns and detects trends that may not be noticeable by other techniques. Furthermore, neural networks have an ability to learn how to do tasks based on the data given for training or initial experience, or with regards to the SOM, it can create its own organisation or representation of the information it receives during learning (Kohonen 2001: 161).

The SOM neural network offers a visual, non-linear methodology for analysing complex, non-linear mortuary data. While the algorithms and the processing done by the method may be complex, the results are displayed in a manner that makes it easy to distinguish features such as position, size, and shape of clusters. Furthermore, the SOM is not constrained in the same manner as an MLP neural network in the way that it yields reliable and accurate classification results; in the latter, a representative set of samples is necessary. If the training data are not representative then the network may fail to classify new data that are dissimilar to all of the training data. In addition, sample size is another issue affecting the reliability of an MLP. A small sample size is not enough for an MLP to recognise all classes and to determine the class boundaries in the feature space precisely, which is one of the main problems with the data used here.

## 4.5 Conclusion

Because the methodology proposed concerns multiple scales in space and time, it is not site specific or level specific, limited to a particular place or time period, or focused on internecine or international conflicts. It can be applied to various regions, various conflicts, and in different time periods, whether prehistoric, historic, or recent.

The reason for the use in this analysis of the traditional multivariate techniques in conjunction with the more novel approach of neural networks, as outlined above, is to develop a comprehensive method that incorporates both quantitative and qualitative data and is capable of recognising patterns in conflict mortuary behaviour as well as producing an easily visualised graphic representation (i.e. SOM) of those relationships.

The following analysis does not focus on the social dimensions of the dead as they are represented in burials. The study of mortuary behaviour in a conflict situation requires the exploration of a context dramatically altered from the social norm, one in which the context of living and dying varies according to the conflict situation, along with patterns of behaviour. It seems appropriate, therefore, to use a flexible analytical approach that may reveal additional information about attitudes, intentions, and other material and ideological aspects of the circumstances that surround the death and burial of individuals and groups in wartime.

# Chapter 5 Application and Results of Multivariate Techniques

## 5.1 Introduction

The model to identify characteristics and patterns of behaviour in conflict burials was tested in four stages using multivariate techniques applied in the same manner to all the data. The purpose of the statistical testing was two-fold: data reduction and classification. The initial testing phase was intended to reduce the number of variables through factor analysis, treating all of the datasets (normative and conflict) as one unit in order for all variation to be considered. The latter three phases of testing were concerned with classification. In the second phase, all the datasets were tested using factor analysis and hierarchical and k-means clustering; the third phase consisted of factor analysis and hierarchical and k-means clustering of only conflict data from all nine sites; and the fourth phase tested the individual sites (normative and conflict data) using the same tests as before.

## 5.2 Review of Multivariate Analyses

The available data determined initially what variables were possible to identify and use. Since the types of data were determined by situation, the focus became that of body treatment. The variables used to indicate body treatment included location identifiers, body position, cause of death, and the presence or absence of normative artefacts. There may be other variables that could provide more information on body treatment and/or the overall context of the site, but the variables that were used to define the cases in this study were common features included in all of the available data.

After determining variables that focused on body treatment (body positioning, grave goods, presence of container, grave marker, and clothing) that were common to all the sites, the aim was to test those variables to distinguish patterns in burial behaviour and the associated context. The approach applied here is similar to that of McHugh (1999) who, in analysing status from artificially constructed data, produced a method for studying mortuary data. He concluded that cluster analysis produced variable results from the technique, some inconclusive, while others were informative and offered clear structure within the data (McHugh 1999: 106-109). Another aim was to test if traditional multivariate techniques could identify burial types from the variables that relate to body treatment.

To facilitate data reduction, the techniques used were factor analysis (e.g. Baxter 1994) and hierarchical cluster analysis – approaches in general use in mortuary studies (e.g. Huggett 1992; Manly 1996). Factor analysis and hierarchical clustering were used to identify correlations that were too high, suggesting that the two variables seemed to be measuring the same aspect, and were not sufficiently distinct. Furthermore, using these two methods would benefit from the analysis of the variables (R-mode analysis) in factor analysis to complement the classifying of cases (Q-mode analysis) of hierarchical clustering by focusing on different components of the data, cases versus variables.

## 5.3 VARIABLE REDUCTION

Factor and hierarchical cluster analyses were applied as a means to explore the data and to reduce the number of variables. All the preliminary testing with factor analysis and hierarchical clustering prepared the data for the final testing phase using hierarchical clustering and k-means clustering. Originally, there were 18 variables per set of remains; this did not include the variables representing artefacts that were associated with an individual. The number of variables was reduced to express the general characteristics of a burial. Furthermore, the database was becoming too complex because of specificity of body treatment and artefacts, while losing the meaning of those attributes. The variables needed to be reduced to concentrate on variables that would describe statistically what is represented (e.g. general artefacts and body treatment) as well as the context of those attributes.

Breaking down artefacts into their components (e.g. buttons, fabric, heel), the database lost their real meaning. A type list was created, but this too was too much detail that it lacked constructive information. Artefacts were reduced to the presence or absence of a limited number of ritual markers (Clothing, Grave Goods, Container, and Grave Marker) in an attempt to retain the meaning of the entities rather than lose them to minute detail (see Table 5.1 for the development of the variables).

The variables at the first and second stages of testing with factor analysis and hierarchical testing were the same. Initial remains variables to identify the individual were Age, Sex, Status, and Cause of Death (CoD). The variables to define body treatment within the grave were Articulation, Orientation range, Arm position, Head position, Body position, Container, Mutilation (Mut) and Commingling. Two additional variables defining body placement were TopMiddleBottom (TMB), RightCentreLeft (RCL); these were used with reference to the commingling of remains to further define a body's placement in relation to other remains in the grave. Most of these variables were reduced for the second stage of testing to reduce complexity of the database and to limit as much as possible the effect of 'noise'. Additionally, artefacts were initially tested separately from the remains with factor analysis. The Artefact table was reduced to five variables representing ritual markers (Container, Marker, Grave Goods, Clothing, and Miscellaneous artefacts) (see Appendix B for all initial variable definitions and tables).

| | Initial Variables | | | First Stage Testing | | | Final Variables | |
|---|---|---|---|---|---|---|---|---|
| *Table* | *Field Names* | *Entries* | *Table* | *Field Names* | *Entries* | *Table* | *Field Names* | *States* |
| Remains | RemainsID | | Remains | RemainsID | | Remains | RemainsID | |
| | TMB *(top/middle/bottom) | 3 | | TMB | 3 | | Normative Body Position | 2 |
| | RCL *(right/centre/left) | 3 | | RCL | 3 | | | |
| | Orientation | | | Orientation | | | | |
| | ArmID | 8 | | ArmID | 8 | | | |
| | HeadID | 9 | | HeadID | 9 | | | |
| | PositionID | 10 | | PositionID | 10 | | | |
| | Articulation | 4 | | Articulation | 4 | | | |
| | Age | | | Age | | | | |
| | Sex | 3 | | Sex | 3 | | | |
| | Cause of Death | 24 | | Cause of Death | 5 | | Cause of Death - Ext Jud | 2 |
| | | | | | | | Cause of Death - Combat | 2 |
| | | | | | | | Cause of Death - Sickness | 2 |
| | | | | | | | Cause of Death - Natural | 2 |
| | Mutilation/Trauma | 10 | | Mutilation/Trauma | 3 | | Mutilation (Present) | 2 |
| | Commingling | 2 | | Commingling | 2 | | Commingling (Present) | 2 |
| | Status | 3 | | Status | 3 | | Status (Civilian) | 2 |
| | ContainerID | 7 | | ContainerID | 7 | | Container (Present) | 2 |
| Artefacts | ArtefactsID | | Artefacts | General Location | 4 | | Marker/No Marker | 2 |
| | General Location | 4 | | Grave Location | 14 | | Clothing/No Clothing | 2 |
| | OIU/BBUn | 7 | | GeneralTypeID | 9 | | Grave Goods/No GG | 2 |
| | Grave Location | 14 | | | | | Misc Artefacts/No Misc. | 2 |
| | Left/Right | 2 | | | | | | |
| | ElementID | 14 | | | | | | |
| | TypeID | 121 | | | | | | |
| | MaterialID | 34 | | | | | | |
| | Quantity | | | | | | | |
| | | | Grave | Obscuration | 5 | | Intentional Obscuration | 2 |
| | | | | GraveType | 3 | | Cemetery Type (Normative) | 2 |

**Body positioning and locational variables (see Appendix B)*

Table 5.1 Variable development

### 5.3.1 Factor Analyses

After preliminary testing of the Artefact table, it emerged that several categories of artefacts contributed little to the understanding of the role of artefacts themselves. For example, the difference between five buttons versus nine, or the difference between the materials of the buttons, provided no useful information, as all that was required was evidence of the presence or absence of clothing. Therefore, many highly specific items were pooled to create one item; for example, eight separate components of one gun would be pooled to represent one item, not eight. Pooling artefacts reduced the overall number of artefacts to be tested, as well as creating more generally defined items better representative of the data for analysis and comparison. The pooled artefacts were reduced to presence/absence variables representing markers, miscellaneous artefacts, and container. This change would then ensure that the significance was not the detail of the artefact but rather the presence or absence of a particular type of artefact. This reduction also avoided clustering based on minor differences because it is the identification of general patterns that is the goal; and since the model is based on general patterns, more specific data relating to body treatment and artefacts are not necessary in defining the model. See Appendix C for variable definition and abbreviations used here.

The clothing type is an example of a group of individual artefacts that went through several steps of reduction. First, the clothing category was created from individual artefacts that could be interpreted as clothing, such as buttons, cloth in certain locations, or items that constitute footwear. After additional analysis, it was determined that a clothing type, broken down to just two types – military or civilian clothing - was all that was needed for the statistics applied here. Clothing would be reduced further to whether or not clothing was present.

Initially, several variables representing body positioning were used, such as head position, arm position, general body layout, and orientation. However, after preliminary testing which resulted in many clusters created from all the possible combinations of variables, as well as clusters based too heavily on minute differences in body orientation, a broader category, BodyPosition (normative) replaced the four original variables (see Table 5.2). Whether a body was placed in a normative manner or not was the point of study, not the individual components of behaviour. In addition, normative patterns were different cross-culturally, which affected the developed clusters. It was not the orientation that mattered, but whether or not it was normative. Consequently, the BodyPosition variable represents, cross-culturally, the presence or absence of normative body position patterns. It was important to create a general presence or absence variable because the detailed element positions may differ among the different cultures represented, but still represent normative behaviour.

The Container variable was reduced in the same way that overall body positioning was reduced. Since there are variations of normative burial containers cross-culturally, the presence or absence of a normative container, whatever that may be, replaced the more detailed options. At this level, it is the presence or absence of a normative container that provides the most information with regards to the burial model.

The goal of factor analysis was to extract artefact variables that symbolised behaviour. It is what is represented by the artefacts that is of importance, not individual items. This was also the reason behind the combining of variables representing body positioning; it is the overall treatment of the body that was of concern, not the position of individual elements. The process of factor analysis assisted in confirming that that it was the broader symbols of behaviour, and not the more detailed data, that was necessary for further analysis.

| | Component | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| SEX | .412 | .276 | -.610 | .152 | -.296 |
| AGE | .187 | | .705 | .184 | .404 |
| STATUS | .544 | | -.313 | .260 | -.174 |
| ORNG | -.761 | | -.110 | | |
| TMB | .435 | -.339 | -.223 | .584 | .294 |
| RCL | .701 | .385 | | .115 | |
| ARM | -.313 | .675 | -.230 | .223 | .272 |
| HEAD | -.588 | .432 | -.326 | | .300 |
| POSIT | -.396 | .319 | | -.349 | .329 |
| CONTAIN | .760 | | .169 | -.233 | |
| COD | .852 | .157 | | | .177 |
| MUT | -.491 | | .165 | .263 | |
| COM | -.327 | -.519 | -.101 | .563 | .180 |
| MARKER | .321 | .559 | .257 | .143 | .156 |
| CLOTHING | -.194 | .385 | .452 | .353 | -.499 |
| GG | .279 | .309 | .166 | .313 | -.102 |
| MISC | -.672 | .161 | .194 | .208 | -.223 |

**Table 5.2** Variable reduction factor analysis component assignment for All Data (correlations that are .1 or less are not listed)

### 5.3.2 Cluster Analyses

As with the factor analysis, agglomerative hierarchical clustering was applied at this first stage in order to identify the correlation between variables. Factor analysis was applied first to have a broad reduction of redundant variables. This was followed by cluster analysis for a finer reduction of variables that were closely correlated in order to remove insignificant variables.

Hierarchical trees illustrated that there was minimal distance between the variables Sex and Status, and that they were components of one cluster (Figure 5.1). An explanation for this is that these two variables were exclusively used in conjunction with one another to describe a person's status. For example, in most cultures, males are military personnel, thereby making sex a redundant variable.

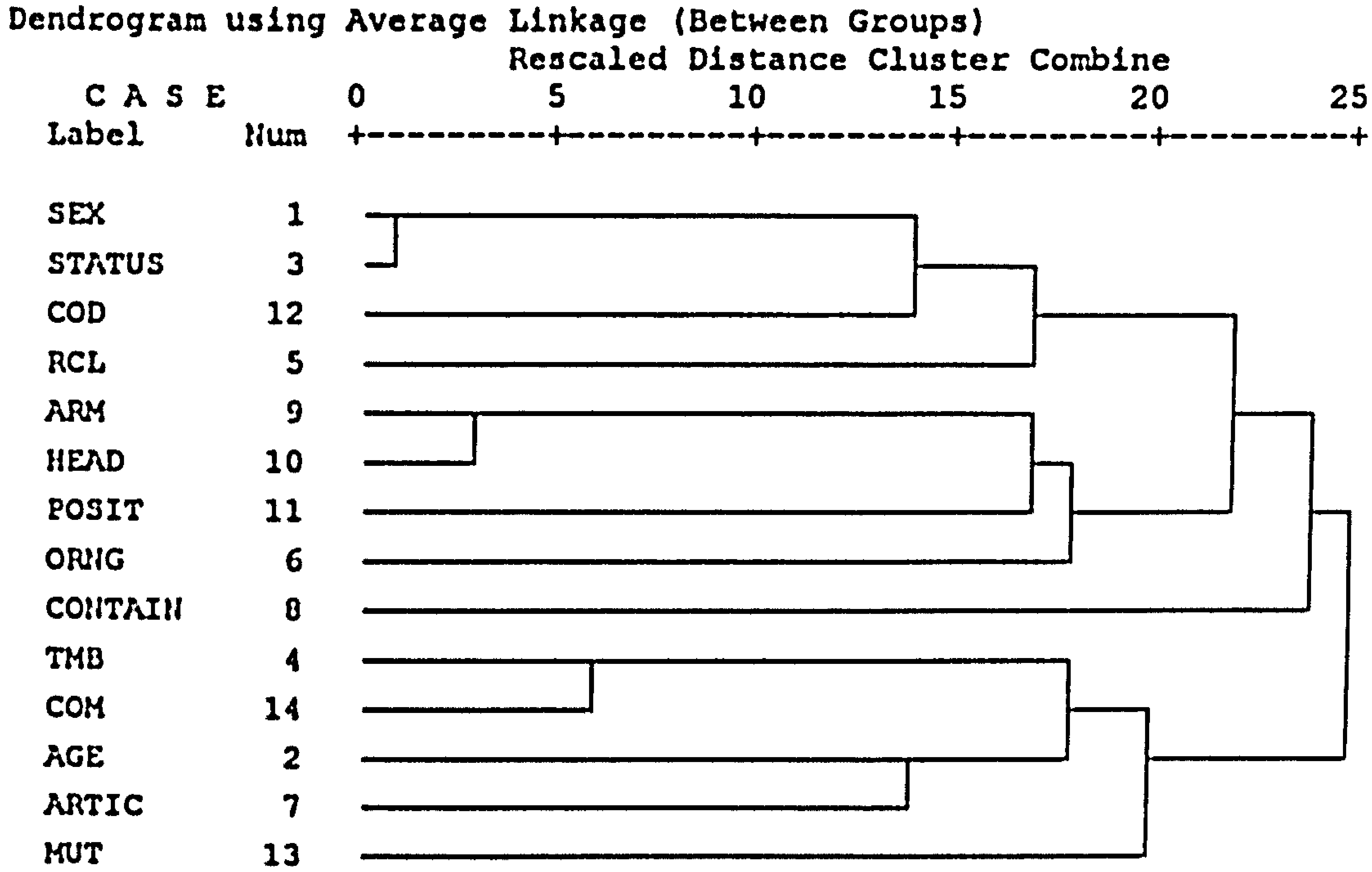


Figure 5.1 Variable reduction hierarchical clustering of All Data: Between-group Average; Jaccard measure of variables

Hierarchical analysis identified additional variables that could be removed, such as Arm and Head positioning variables. These two could be discarded because there was little distance between the two variables and because an overall normative body position variable would combine all of the separate variables describing body positioning. In this study, it is one component of the broadly defined normative body position (comprised of the positioning of the arms, head, and general body). This variable is reduced to the presence or absence of a normative body position within the grave. After the hierarchical analysis of the variables to identify variables that were strongly related, the cases were then analysed. These steps led to the k-means testing phase, which was the final phase in the data reduction process.

### 5.3.3 K-means clustering

The k-means testing used the same variables that both factor and cluster analyses used, as well as the variables that were developed after the factor and cluster analyses. The results from the k-means testing confirmed the results from both factor and cluster analyses regarding the variables that could be removed or combined. K-means also identified the need to reduce the options for the Cause of

Death variable (see Table 5.3). There were initially 28 options for cause of death, many of which were just variations on a general theme, such as three location options for a gunshot wound; therefore, the cause of death options were reduced to four; for the purposes of continuity, the term 'cause of death' (CoD) will continue to be used, yet it is the 'manner of death' that is being defined. These four represent the general manner of death, i.e. combat-related, sickness/disease, natural, and if applicable, intent, i.e. extra-judicial because more specific causes are just variations on these broadly based causes of death. The extra-judicial designation is based on the types of trauma present and the time period from which the remains are from. It is also important to note that military status individuals do not posses CoD-CR automatically based on that status, but rather on the physical evidence that is present.

| | Cluster | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| SEX | 1 | 2 | 1 | 1 | 2 |
| STATUS | 2 | 2 | 2 | 2 | 2 |
| ORNG | 3 | 5 | 3 | 1 | 3 |
| TMB | 2 | 2 | 2 | 2 | 2 |
| RCL | 3 | 2 | 4 | 6 | 5 |
| ARM | 4 | 8 | 4 | 3 | 4 |
| HEAD | 3 | 9 | 3 | 2 | 3 |
| POSIT | 3 | 5 | 4 | 2 | 3 |
| CONTAIN | 2 | 1 | 2 | 3 | 2 |
| COD | 11 | 12 | 9 | 23 | 15 |
| MUT | 1 | 0 | 1 | 0 | 0 |
| COM | 0 | 0 | 0 | 0 | 0 |
| MARKER | 0 | 0 | 0 | 1 | 0 |
| CLOTHING | 1 | 0 | 1 | 1 | 0 |
| GG | 0 | 0 | 0 | 0 | 0 |
| MISC | 0 | 0 | 0 | 0 | 0 |
| AGE | 238 | 0 | 400 | 504 | 117 |

**Table 5.3 Variable reduction k-means clustering of All Data: Cluster membership 5; Squared Euclidean distance**

Another variable that was reduced to a presence/absence variable was Mutilation. For the purposes of the analysis, it was the presence or absence of the action, not the variation in the type or location that was important. For example, where the mutilation is placed on the body is not as important as to whether or not there is mutilation present. Furthermore, not all the subtle variations of that behaviour would have meaning because the cultures represented in the dataset do not perform ritual mutilation; therefore, the presence of mutilation here would indicate non-normative behaviour.

The results from the data reduction stage helped the following stages of testing using hierarchical and k-means clustering because of the removal of redundant variables. The preliminary testing process identified variables that were superfluous and did not contribute to the understanding of the burial, and in some instances, variables that were at odds with the testing process. One example of variables affecting the overall performance of the k-means testing was the variables defining body position (upper limb, head, and general body position). Problems with erroneous cluster assignment were caused by the more specific element's positioning versus the general intent of the overall body positioning (i.e. normative body positioning). These variables could be used on a more detailed intra-site examination, which is beyond the scope of this study.

## 5.4 Results of Statistical Analysis

The data were tested in three basic samples: all data; all conflict data; and site data composed of conflict and normative data representing an area of study (for example, all Spanish data tested as one site). Three types of clustering methods were used at this stage for each of the three samples for testing. Hierarchical clustering was used to test both the cases, and the factor scores for the cases.

### 5.4.1 All Data Results

The dataset consists of 434 cases, which included the conflict and normative cases ranging from the medieval period (1461) to modern times (1995). Of these 434 cases, 183 individuals in 89 graves comprise the conflict portion of the data, and 251 individuals in single graves form the comparative normative data. All 14 variables were used at this level since none of the variables had zero variance. See Appendix F Tables F.1-7 and Figures F.1-2.

#### 5.4.1.a Factor Analysis Results

Factor analysis of the 14 variables extracted five factors, which appeared to separate conflict causes of death (e.g. CoD-CR and CoD-EJ) from normative causes of death (Table 5.4). See Appendix D.3.7 for abbreviations used to identify variables.

| | Component | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| STATUS | .735 | .488 | -.249 | -.124 | |
| CONTAIN | .853 | | | .138 | |
| CODCR | -.687 | -.501 | .303 | .161 | |
| CODEJ | -.405 | .770 | -.156 | -.124 | -.151 |
| CODSD | .341 | | -.491 | .687 | -.122 |
| CODN | .512 | .103 | .513 | -.386 | .219 |
| MUT | -.520 | -.238 | .298 | .160 | -.313 |
| MARKER | .529 | .150 | .473 | .245 | |
| CLOTHING | | .617 | .443 | .370 | -.124 |
| GG | .268 | | .436 | .234 | |
| BODPOSIT | .775 | | | | |
| MISC | -.656 | .430 | .166 | .171 | |
| CEMTYPE | .641 | -.497 | | | -.265 |
| OBINTNT | -.166 | | -.123 | .242 | .869 |

**Table 5.4** Factor analysis component assignment for All Data
(correlations that are .1 or less are not listed)

In addition, many of the normative attributes (e.g. CoD-SD and CoD-N, Clothing, and GG (grave goods)) had high positive loadings in Factor 1, while other variables that suggest conflict behaviour, including 'Cause of Death-Extra Judicial' and Miscellaneous Artefacts had high negative loadings in the same factor. The first two factors represent the greatest amount of variance among the burials and represented 45.47% of the variance (see Table F.1). Factor 3 was comprised of variables with moderately high positive loadings for traditionally more normative behaviour attributes, such as Marker, Grave Goods, and CoD-N.

At the broadest scale, 'All Data', the factor correlation matrix scores indicated strong relationships between variables associated with normative burials with high positive scores, and highly negatively correlated to variables associated with non-normative burials (see Table F.3). Overall, the correlation matrices indicate strong positive and negative correlations among expected variables, for example, Status (civilian) had a high negative correlation to CoD-CR. This patterning of variables represented what would be an expected cause of death for civilians versus military personnel. There were also high positive correlations between Container and Status (civilian), CoD-N, BodyPosition and Marker. These results are consistent with correlations one would expect between conflict and normative burials within the context of burial characteristics.

### 5.4.1.b Hierarchical Clustering Results

The results from the between-group cluster analysis demonstrate a good structure, differentiating between normative and conflict burials using all 14 variables. The dendrogram (Figure F.2) illustrates this major division between burial types, it splits the burials into normative and conflict components first. There are three cases of normative burials in the greater military cluster, these however belong to the military status (based on age, sex, and associated artefacts) cases from the Fishergate data (cases 38, 39, and 145) demonstrating that hierarchical clustering identifies Cause of Death (Natural and Sickness/Disease versus Combat Related and Extra-Judicial) at the first level of clustering separation. Following the broader division between normative and conflict burials, the conflict burial cluster is subsequently divided into groups separated by civilian versus military status as well as Cemetery and Container. This division is followed by the presence of container among the military cases. Overall, the distances between cases within the normative cluster are not as far as the distance in which the conflict cases are combined because the normative cases are similar, whereas, the conflict cases are quite diversified.

The cluster membership (Table 5.5 (the Burial Type listed is based on a clear majority of cases assigned to a cluster)) at the four cluster level separates these same three Fishergate burials from normative burials (Cluster III). This method differentiated between civilian and military status in the burials using 14 variables with 99% (248) of the normative cases placed in one cluster (III) and 63% (116) of the conflict burials placed in Cluster I and 31% (56) of the conflict burials in Cluster II. Ten conflict period cases (2% of the total) were separated (Cluster IV) (see Table 5.6) from the other cases because none of the cases had a known cause of death. In addition, there was one conflict case (case 116 from the North Korea dataset) (see Appendix H for individual case records) that was placed in the normative cluster (III) because the cause of death was sickness/disease.

There was a minority of cases within Clusters I and II that had characteristics not listed in Table 5.6 because only a small number of cases had such attributes. For example, nine cases (16% of Cluster II) had military status as a characteristic;

likewise only 36 cases in Cluster I (31% of 116 cases) and 10 (18% of 56 cases) in Cluster II had BodyPosition as a characteristic.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 1-43,46-81,83-96,99,101,102,105,108-115,117-136,145,147,148 |
| II | Conflict | 44,45,97,98,100,103,104,106,107,137-144,146,149-187 |
| III | Normative | 116,188-434 |
| IV | Conflict | 77,82,86-93 |

**Table 5.5** Cluster assignment for All Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, CoD-CR, Mutilation, Marker, NormCemtery |
| II | Civilian, CoD-EJ, Clothing, Misc.Artefacts |
| III | Civilian Status, CoD-SD, CoD-N, Clothing, Marker, Container, Body Position, NormCemtery, Grave Goods |
| IV | Military Status, NormCemtery |

**Table 5.6** Variables represented in cluster assignment for All Data

In addition to clustering burials based on all the 14 variables, factor scores were calculated for all the burials. These results were then processed using cluster analysis. The clustering based on factor scores had some clusters similar to the clustering based on the 14 variables (Table 5.7), such as Cluster I was assigned 112 (61%) of the same conflict cases as the results based on the variables; a difference of only four cases. Cluster II of the factor score results was almost identical to the results based on variables. However, this clustering method performed poorly based on identifying between civilian and military status. Not only were 112 of the conflict cases assigned to Cluster I, but 94% (235) of the normative cases were also assigned to Cluster I. The remaining 16 normative cases were assigned to Cluster IV. Obscuration and the presence of Grave Goods influenced cluster membership at this stage (see Table 5.8). It appeared that the method was heavily influenced by the presence of outliers. Neither clustering based on variables nor factor scores could separate the cases beyond the general normative versus conflict period burials.

| Cluster | Burial Type | Case |
|---|---|---|
| I | --- | 1-43,46-96,99,101,102,105,108-115,119,120,122-135,145, 147,148,188-389,403,405-429 |
| II | --- | 44,45,97,98,100,103,104,106,107,137,139-144,146,149-187 |
| III | Conflict | 116,117,118,121,138 |
| IV | Norm | 390-402,404,430,431,434 |

**Table 5.7** Cluster assignment for factor scores for All Data

| Cluster | Outlying Variable(s) |
|---|---|
| III | Obscuration |
| IV | Grave Goods |

**Table 5.8** Variable(s) of outlying cases represented in cluster assignment for factor scores for All Data

### 5.4.1.c K-means Clustering Results

The k-means clustering method was set to assign four clusters, representing the three conflict burial types - friendly, neutral and hostile, as well as normative burials using all 14 variables. See Appendix F Tables F.5-7 for the cluster assignments and the components of each cluster obtained.

The results of the k-means analysis had some similarities to the hierarchical clustering results (Table 5.9). Of the four clusters extracted, two clusters were comprised of the conflict data, one of which was comprised of military status and the other, civilian. The remaining two clusters consisted of the normative data.

The k-means Cluster I was almost identical to the hierarchical clustering of the variables Cluster I with the same 110 cases; however, there was a difference of six cases assigned to Clusters II and IV. In addition, Cluster IV had similar make-up to Cluster II from the hierarchical clustering results. Fifty-five cases were in both clusters with only two different cases in Cluster IV and one removed from the cluster. The two clusters of normative burials are separated by the cause of death variable. Cluster III cause of death is defined as CoD-SD; however, 31% of the cases (23) assigned to Cluster III have CoD-N as a variable. On the other hand, Cluster II does not have a defined cause of death; however, 72 cases (41%) in Cluster II have either CoD-N (16 cases) or CoD-SD (56 cases) as a cause of death. The k-means clustering method allowed one variable to dominate other, equally important variables, at the expense of properly defined clusters. Furthermore, the k-means clustering was unable to identify burials beyond the general normative versus conflict period burials.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 1-43,46-57,59,61,63-96,99,101,102,105,108-115,117-135,145 |
| II | Norm | 58,60,62,188-220,222-236,238-246,250-255,257-267,270,272,273,276, 281-285,289,290,292,294-303,305,306,309-317,319-321,323-329, 332, 335,337,339,340,342,344-347,349,351-354,356,358,365,366,368,370, 372,374-378,382,384,385,388,389,391,392,394-397,399, 400-403,405,409-411,413,415,417,418,420,421,425,427,429,434 |
| III | Norm | 161,221,237,247-249,256,268,269,271,274,275,277-280,286-288, 291,293,304,307,308,318,322,330,331,333,334,336,338,341,343,348, 350,355,357,359-364,367,369,371,373,379-381,383,386,387, 390,393,398,404,406-408,412,414,416,419,422-424,426,430-432 |
| IV | Conflict | 44,45,97,98,100,103,104,106,107,116,136-144,146-160,162-187 |

**Table 5.9** K-means cluster assignment for All Data

### 5.4.1.d Discussion

The testing of all of the data demonstrated the general patterns in burial behaviour and identified broad variations from the norm. At initial examination, the patterns of cluster memberships appeared to be quite similar among clustering methods; however, some marked differences emerge, such as the initial similarity between Cluster I in the hierarchical clustering of variables and the clustering of factor scores. However, upon closer inspection, the cluster not only includes the same conflict burials, but also assigns 94% of the normative cases to the same cluster. In addition, the results varied greatly between hierarchical clustering of the data and k-means clustering.

In general, the results tended to suggest an individual's status (civilian or military) for most datasets. Single large clusters around zero distance are identified heavily in the normative sites. Both methods, hierarchical cluster and k-means clustering, produced good differentiation of normative versus conflict burials using the 14 variables; however, the k-means clustering relied heavily on the cause of death variables for determining cluster membership. The most accurate and clearly defined results are those based on between-average clustering of the 14 variables because the effect of outliers is reduced using the between-average method (Baxter 1994: 180). The k-means clustering method proved to be less successful than hierarchical clustering in correctly constructing clusters, and the hierarchical clustering based on factor scores was clearly the least accurate in defining clusters because of the effect of outliers in the data affecting the factor scores. Overall, none of the methods applied to all of the data were able to differentiate burials beyond the general normative versus conflict period burials. The next step was to analyse only conflict data in order to test whether the statistical methods would be able to identify the various conflict period burials without the normative cases dominating the subtle distinctions between the conflict burials.

### 5.4.2 ALL CONFLICT DATA

The Conflict dataset consists of 183 individuals in 89 graves, which included cases ranging from the medieval period (1461) to modern times (1995). Thirteen of the 14 variables were used because one had zero variance (CoD-N). See Appendix F Tables F.8-14 and Figures F.3-4.

#### 5.4.2.a Factor Analysis Results

Factor analysis of the 13 variables (see Appendix D.3.7 for abbreviations used to identify variables) extracted five factors (Table 5.10). These components appeared to be separated based on the different causes of death. For example, the conflict causes of death (e.g. CoD-CR and CoD-EJ) had high loadings in Factor 1, whereas a perceived normative cause of death had a high loading in Factor 3.

| | Component | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| STATUS | .892 | | | -.164 | |
| CONTAIN | -.161 | .675 | .331 | | |
| CODCR | -.761 | -.102 | | .348 | -.247 |
| CODEJ | .880 | | -.125 | -.158 | .226 |
| CODSD | | -.334 | .676 | .219 | .306 |
| MUT | -.264 | | -.360 | .293 | .688 |
| MARKER | | -.132 | -.290 | .660 | -.188 |
| CLOTHING | .609 | .472 | | .425 | |
| GG | -.132 | | -.134 | -.128 | .480 |
| BODPOSIT | | .689 | .385 | .127 | |
| MISC | .482 | | | .658 | |
| CEMTYPE | -.620 | .418 | | | .396 |
| OBINTNT | | -.382 | .714 | .150 | .205 |

**Table 5.10** Factor analysis component assignment for Conflict Data (correlations that are .1 or less are not listed)

In addition, many of the more normative attributes (e.g. CoD-SD and CoD-N, Clothing, and grave goods) are separated from other variables that suggest conflict behaviour, including 'Cause of Death-Extra Judicial' and Miscellaneous Artefacts. Three of the factors represent the greatest amount of variance among the burials and represented 49.14% of the variance. Factor 2 was comprised of variables with high positive loadings for traditionally more normative behaviour attributes, such as container, normative body position and normative cemetery type (see Table F.8).

The correlation matrix scores indicated strong correlations between variables associated with normative burials by having high positive scores and, conversely, highly negative correlations to variables associated with non-normative burials (see Table F.10). The two causes of death used (CoD-CR and CoD-EJ) and Status appeared to be the dominant variables in the Conflict dataset.

Status had a high positive correlation to CoD-EJ and had a high negative correlation to CoD-CR. This pattern of variables representing what would be an expected cause of death for civilians versus military personnel was expected. These results are consistent with correlations one would expect between military versus civilian status within the context of burial characteristics.

There were few strong correlations among the variables in the Conflict datasets; however, those few correlations that were present had very strong positive and negative scores. Furthermore, the results were among variables that would be expected to have high correlation values. However, the overall results of the factor analysis did not indicate a strong pattern among the variables when all the conflict datasets were applied.

#### 5.4.2.b Hierarchical Clustering Results

There is good structure recovery from the between-group method of cluster analysis when testing the model with all the conflict data. This method differentiated between civilian and military status in the burials using 13 variables with 100% of the normative cases placed in Cluster III and 96% (27) of the conflict burials placed in Cluster I. The one conflict burial assigned to Cluster II (case 95 from the North

Korea dataset) was separated because of the different cause of death (CoD-SD) than the other conflict burials (Table 5.11). The dendrogram (Figure F.4) splits the burials into military and civilian components first. Then the military cluster is subsequently divided into groups separated by normative body positioning, normative cemetery and Container, followed by the presence of Commingling. In addition, three of the four 19th Century North America (Antietam, Ox Hill, and Snake Hill) datasets are clearly separated from the other burials in the greater military based cluster; however, the cases from the fourth North America dataset (Custer) are spread throughout the larger military cluster (see Appendix H for individual case records).

| Cluster | Burial Type | Case |
|---|---|---|
| I | Friendly | 1,2,4-8,39,41,77 |
| II | 66% Friendly<br>34% Hostile | 3,9-32,37,38,40,42-49,51-73,75,76,78-103,106,108,109,112,<br>116-118,134-154,183 |
| III | Hostile | 33-36,50,74,104,105,107,110,111,113-115,119-133,155-182 |

**Table 5.11** Cluster assignment for Conflict Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, NormCemtery |
| II | Military Status, CoD-CR, Mutilation, Clothing, Misc.Artefacts |
| III | Civilian Status, CoD-EJ, Mutilation, Clothing, Misc.Artefacts, NormCemtery |

**Table 5.12** Variables represented in cluster assignment for Conflict Data

There were a minority of cases within Clusters II and III that had characteristics not listed in Table 5.12 because only a small number of cases had such attributes. For example, three cases from the Benegiles site (5% of Cluster III) and 14 cases (12%) of Cluster II (all from the Custer site) had Marker as a characteristic; likewise only ten cases (eight cases from the Spain data and two from the Croatia data) in Cluster III (17.5%) and 34 (29%) in Cluster II (a majority from the Antietam, Snake Hill and Ox Hill sites; five from North Korea, one from Croatia, and three cases from Towton) had BodyPosition as a characteristic.

In addition to clustering burials based on the 13 variables, factor scores were calculated for all the burials. These results were then processed using cluster analysis. The clustering based on factor scores was quite different from clustering based on the 13 variables, unlike the analysis of the factor scores for 'All Data', the results for 'Conflict Data' were not good. This clustering method performed poorly based on identifying between civilian and military status. All of the burials (181) barring 2 cases (1%) were assigned to Cluster I, with those two cases being assigned to Clusters II and III (from North Korea and Towton, respectively). CoD-SD and the presence of grave goods influenced cluster membership at this stage (see Tables 5.13 and 5.14). The method appeared to be heavily influenced by outliers.

| Cluster | Case |
|---|---|
| I | 1-94,96-182 |
| II | 95 |
| III | 183 |

**Table 5.13** Cluster assignment for factor scores for Conflict Data

| Cluster | Outlying Variable(s) |
|---|---|
| II | Cause of Death – Sickness/Disease |
| III | Grave Goods |

**Table 5.14** Variable(s) of outlying cases represented in cluster assignment for factor scores for Conflict Data

### 5.4.2.c K-means Clustering Results

The k-means clustering method was set to assign three clusters, representing two of the model's three conflict burial types, friendly, hostile, and normative, using 13 of the 14 variables. Conflict neutral burials were not selected to be separated at this stage because many of the attributes are similar to the other conflict burials and as such, would not be clearly separated. The clustering method performed poorly at identifying a fourth cluster. See Appendix F Tables F.12-14 for the cluster assignments and the components of each cluster obtained.

The resulting clusters of the k-means analysis were similar to those extracted using hierarchical clustering (Table 5.15). The three clusters extracted included two with military status and one civilian cluster. K-means incorrectly assigned one civilian (out of 51 civilian cases) to Cluster I and 12 military cases (9% of all military cases) to Cluster II. These cluster assignments appear to be based on the cause of death (CoD-SD and CoD-EJ in the cases of the military cases in Cluster II).

The variable Normative Cemetery appeared to be an influential component of Cluster III with 39% (35 cases) of the members of Cluster III possessing that attribute; however, at the same time, 34% (30 cases) of Cluster III were also commingled, which is not necessarily normative behaviour in a normative cemetery setting of the cultures represented by the datasets.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Friendly (military) | 30,31,32,48,49,63,68,69,70,71,72,73,89,90,96,116,134-136, 138,140-144,148-154 |
| II | Hostile (civilian) | 33,34,35,36,50,74,95,104,105,107,110,111,113-115,117-133, 155-182 |
| III | 68% Friendly 32% Hostile | 1-29,37-47,51-62,64-67,75-88,91-,94,97-103,106,108,109, 112,137,139,145-147,183 |

**Table 5.15** K-means cluster assignment for All Conflict Data

The cluster assignment defined three clearly separated clusters that did mirror the burials based on the types of body treatments, such as Mutilation and Commingling, among burials. However, k-means clustering allowed one variable, such as cause of death, to dominate other, equally important variables, at the expense of properly defined clusters

#### 5.4.2.d Discussion

The testing of all the Conflict data demonstrated the broad patterns in conflict burial behaviour. The diversity of data, regions, and conflict type affected the clustering of attributes, with some of the attributes becoming secondary to some dominant variables. The resulting clusters varied greatly between hierarchical clustering of the data and hierarchical clustering of factor scores, whereas the results from hierarchical clustering and k-means clustering were quite similar. While the patterns of cluster assignment among the methods are primarily the same, there were some minor differences between methods as well as the clusters being defined differently.

In general, the results tended to indicate an individual's status (civilian or military) for most datasets. Single large clusters around zero distance are identified in all sites. This may indicate that there is an overall similarity of the contextual aspects of conflict burial behaviour through the centuries. There appeared to be a general pattern in disposal during conflict periods, depending on the context (such as execution, during battle, or during the cessation of hostilities), but period or geographic location did not appear to influence mortuary behaviour.

### 5.4.3 Spain Data

The Spanish data consists of 68 cases, 34 from four conflict sites from the Spanish Civil War (1936-1939), and 34 cases representing normative burials from northern Spain and the Basque region from the early 20th century. Ten of the 14 variables (see Appendix D.3.7 for abbreviations used to identify variables) were used because four had zero variance (status, CoD-CR, Clothing, and Obscuration). See Appendix F Tables F.15-21 and Figures F.5-6.

The four graves from the four conflict period sites are mass graves located in non-descript areas, such as in the woods, the side of the road, in a vacant field (the one difference being the Benegiles grave, which was a mass grave in a cemetery). All of the remains appeared to be unceremoniously placed in the grave, in all manner of directions and often commingled. There was evidence of executions having taken place at the site of the graves based on the presence of spent cartridge casings and bullets in and around the graves. Furthermore, the graves were comprised of male and female civilians, some as young as 16 and others as old as 68 years of age. Some of the individuals were buried in medical uniforms (there were nurses and one doctor) indicating a hasty burial. Apart from the mass grave in the Benegiles cemetery, the other graves did not have any normative ritual markers present, such as containers, grave goods or markers. It would appear that from the body treatment and general lack of ritual markers that the graves were hasty hostile burials during open hostilities.

#### 5.4.3.a Factor Analysis Results

Factor analysis extracted two factors that appeared to separate the two types of 'natural' causes of death and grave goods from all the other variables, including 'Cause of Death-Extra Judicial' (Table 5.16). In addition, the high negative and positive loadings in Factor 1 suggest mutually exclusive types of behaviour. These results are consistent with correlations one would expect between conflict versus normative burial characteristics. Factor 1 represented 45.92% of the variance (see Table F.15).

| | Component | |
|---|---|---|
| | 1 | 2 |
| CONTAIN | .894 | |
| CODEJ | -.881 | |
| CODSD | .429 | .748 |
| CODN | .513 | -.651 |
| MUT | -.394 | |
| MARKER | .789 | |
| GG | .169 | .621 |
| BODPOSIT | .847 | |
| MISC | -.747 | |
| CEMTYPE | .936 | |

**Table 5.16** Factor analysis component assignment for Spain Data (correlations that are .1 or less are not listed)

The correlation matrix (see Table F.17) indicates high positive correlation scores for Container to Marker and Body Position. Conversely, CoD-EJ and Misc. Artefacts have high negative correlation scores suggesting that a normative container would not be associated with either that type of cause of death or the presence of miscellaneous artefacts. This pattern extends to the other variables as well, such as BodyPosition, which has a high negative correlation to Miscellaneous Artefacts, but a high positive correlation to Marker.

### 5.4.3.b Hierarchical Clustering Results

The results from the between-group cluster analysis demonstrate a good structure, differentiating between normative and conflict burials using 10 of the 14 variables. The dendrogram (Figure F.6) illustrates the major division between the two major types of burials. There is also grouping within the two major clusters representing, most distinctly, the smaller conflict burial (Benegiles) from the other conflict burials. The Benegiles site contains some aspects found in normative burials (i.e. Marker, Grave goods, within a cemetery) (Table 5.18), hence placement closer to the larger, normative cluster, but still within the conflict cluster (see Appendix H for individual case records). The cluster membership (Table 5.17) at the three cluster level was able to separate these 'Friendly' burials from normative (Cluster I) and conflict (Hostile) burials (Cluster II), and the three outliers made-up Cluster III.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Norm | 1,7,8,9,10,11,13,14,15,16,17,18,19,20,21,50,51,52,53,54,55,56 57,58,59,60,61,62,63,64,65,66,67,68 |
| II | Hostile | 2,3,4,5,6,12,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39 40,41,42,43,44,45,46,47,48,49 |
| III | Friendly | 22,23,24 |

**Table 5.17** Cluster assignment for Spain Data

| Cluster | Variable(s) |
|---|---|
| I | Civilian Status, Container, CoD-SD, Cod-N, Marker, Clothing, BodyPosition, NormCemtery, Grave Goods |
| II | Civilian Status, CoD-EJ, Mutilation, Clothing, Misc.Artefacts |
| III | Civilian Status, CoD-EJ, Mutilation, Clothing, Misc.Artefacts, Marker, NormCemtery, Grave Goods |

**Table 5.18** Variables represented in cluster assignment for Spain Data

In addition to clustering burials based on 10 of the 14 variables, factor scores were calculated for all the burials. These results were then processed using cluster analysis. The clustering based on factor scores were markedly different from clustering based on the 10 variables. In addition, this clustering method performed poorly based on identifying normative versus conflict burials. With 68% of the normative cases (23) and 100% of the conflict cases creating Cluster II, with the remaining 32% of normative cases being assigned to Clusters I and II, cluster membership was influenced by CoD-SD and the presence of grave goods (see Tables 5.19-5.20).

| Cluster | Burial Type | Case |
|---|---|---|
| I | Norm | 1 |
| II | ---- | 2,3,4,5,6,12,22-68 |
| III | Norm | 9,10,11,15,16,17,18,19,20,21 |

**Table 5.19** Cluster assignment for factor scores for Spain Data

| Cluster | Outlying Variable(s) |
|---|---|
| I | Cause of Death – Sickness/Disease, Grave Goods |
| III | Cause of Death – Sickness/Disease |

**Table 5.20** Variable(s) of outlying cases represented in cluster assignment for factor scores for Spain Data

The clustering result's based on factor scores suggest a structure based on cause of death variables. In contrast, clusters based on the 10 variables focused membership on the ritual markers (i.e. Marker, grave goods, and Miscellaneous Artefacts).

### 5.4.3.c K-means Clustering Results

The k-means clustering method was set to assign three clusters, representing normative, conflict friendly and conflict hostile burials using 10 of the 14 variables. Conflict neutral burials were not selected to be separated at this stage because many of the attributes are similar to those of the other conflict burials, and as such, will not be clearly separated in addition to the clustering method performed poorly. See Appendix F Tables F.19-21 for the cluster assignments and the components of each cluster obtained.

The method correctly assigned 100% of the normative burials as one cluster (Cluster III). Conversely, the conflict burials were not identified as clearly (Table 5.21). Of the 34 conflict burials, three sets of remains (9% of conflict burials), were within the confines of a cemetery, had a marker, and had grave goods present; however, 24% of the conflict burials were assigned Cluster I membership. Moreover, cluster assignment was based on the presence of Body Position, which was not the case for any of the sets of remains.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 2,23,24,28,30,35,41,43 |
| II | Conflict | 3,4,5,6,12,22,25,26,27,29,31,32,33,34,36,37,38,39, 40,42,44,45,46,47,48,49 |
| III | Norm | 1,7,8,9,10,11,13,14,15,16,17,18,19,20,21,50,51,52,53, 54,55,5657,58,59,60,61,62,63,64,65,66,67,68 |

**Table 5.21** K-means cluster assignment for Spain Data

Furthermore, it appears that when one variable is removed, for example commingling (which can be suggested as being aberrant behaviour, therefore redundant when the variable BodyPosition is used), another single variable determines which cluster a burial is assigned. For example, the variable Marker determined that three conflict burials should be clustered in the 'Normative' cluster based on the presence of the marker to exclusion of the other variables.

#### 5.4.3.d Discussion

Both clustering methods using 10 of the 14 variables produced good differentiation of normative versus conflict burials, though basing the clusters on different variables. The clusters that emerge are primarily based on cause of death. The clusters based on factor scores, however, are badly skewed by the 11 (16% of total) cases of a different cause of death. The most accurate and clearly defined results are those based on between-average clustering of the 10 variables. This allowed a more general cluster to emerge, not a more-specialised cluster to be extracted; and it is this general identification that is the desired result. Hierarchical clustering of the Spain data based on the variables was the only method to separate the burials according to the burial model; it identified the three friendly burials from the other burial types.

### 5.4.4 KOREA DATA

The Korea data consists of 83 cases, 28 burials from 22 different locations from the Korean War (1950-1953), 28 cases of normative burials from South Korea and 27 normative burials from Yankton, South Dakota, both from the mid-20$^{th}$ century, are indicative of the normative behaviour of two of the primary cultures involved in the conflict represented by the conflict data. The Korean and American burials illustrate how one can tell the difference, statistically, between conflict burials of conflict and normative burials. Twelve of the 14 variables (see Appendix D.3.7 for abbreviations used to identify variables) were used because two had zero variance (CoD-EJ and Mutilation). See Appendix F Tables F.22-28 and Figures F.7-8.

Eighteen of the 28 graves from the conflict sites are single graves located in non-descript areas, such as in the woods, the side of the road, or in a vacant field. The remaining ten graves are secondary burials. All of the remains appeared to be unceremoniously placed in the grave, in all manners of directions and in the case of multiple interments, commingled. Many of the burials had been disturbed, or were secondary burials and most were in varying degrees of disarticulation. There was evidence that death had taken place in or around the site of the primary graves from the presence of spent cartridge casings and bullets in and around the graves and other military paraphernalia. Furthermore, the graves were comprised of male military personnel. One grave (case 1) did have some ritual markers present including a container and a marker. However, the other 27 graves did not have any normative ritual markers present, such as containers, grave goods or markers. It would appear that from the body treatment and general lack of ritual markers that the graves were hasty burials during open hostilities.

### 5.4.4.a Factor Analysis Results

Factor analysis of the 12 variables extracted three factors. Two factors represent the greatest amount of variance among the burials (Table 5.22). Status, Container, and normative cemetery type had high positive loadings in Factor 1 and represented 48.94% of the variance. The third factor comprised of characteristics with moderately high factor loadings for grave goods and Clothing, representing secondary variation, which accounted for an additional 8.7% variance (see Table F.22).

| | Component | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | .980 | | |
| CONTAIN | .863 | | |
| CODCR | -.957 | -.101 | |
| CODSD | .235 | .796 | -.289 |
| CODN | .462 | -.584 | |
| MARKER | .745 | | |
| CLOTHING | .500 | .383 | .432 |
| GG | .245 | .116 | .813 |
| BODPOSIT | .822 | | -.147 |
| MISC | -.596 | .276 | .192 |
| CEMTYPE | .980 | | |
| OBINTNT | -.359 | .325 | -.188 |

**Table 5.22** Factor analysis component assignment for Korea Data (correlations that are .1 or less are not listed)

The correlation matrix (Table F.24) indicates high positive correlation scores for Container to Status, Cemetery Type, Marker, and BodyPosition. Status also had a high negative correlation to CoD-CR. This pattern of variables representing normative behaviour with high negative correlations to variables representing non-normative behaviour extends to the other variables as well, such as Cemetery Type, which has a high negative correlation to Miscellaneous Artefacts, but a high positive correlation to normative body positioning. All of these results are consistent with correlations one would expect between conflict versus normative burial characteristics.

### 5.4.4.b Hierarchical Clustering Results

There is good structure development from the between-group method of cluster analysis. The dendrogram (Figure F.8) splits the burials into conflict and normative components first. These two clusters are subsequently divided into groups defined by body position, followed by the presence of miscellaneous artefacts. The cluster membership (Table 5.23) at the three-cluster level separates the conflict burials (Cluster I) from the normative burials (Cluster III), with the remaining case making-up Cluster II. This method perfectly differentiated between normative and conflict burials using 12 variables with 100% of the normative cases placed in one cluster (III) and 96% (27) of the conflict burials placed in Cluster I. The one conflict burial, which alone makes Cluster II, was separated because of the different cause of death (CoD-SD) from the other conflict burials (see Table 5.24 for variables) (see Appendix H for individual case records).

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 1-8,10-28 |
| II | Hostile | 9 |
| III | Norm | 29-83 |

**Table 5.23** Cluster assignment for Korea Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, CoD-CR, Misc.Artefacts, Obscuration Clothing |
| II | Military Status, CoD-SD |
| III | Civilian Status, CoD-N, Clothing, Container, BodyPosition, NormCemtery, Marker, Grave Goods |

**Table 5.24** Variables represented in cluster assignment for Korea Data

Hierarchical clustering based on factor scores was also performed. The clustering based on factor scores not only differed greatly from clustering based on the 12 variables, but this clustering method had very poor results separating normative versus conflict burials, with mixed cluster assignments among the normative burials. Twenty-seven of the conflict burials (96%) and 69% of the normative cases (38) were assigned to Cluster I. Cluster II was comprised of one conflict burial and ten (18%) normative burials with the remaining 13% of normative cases being assigned to Cluster III (Table 5.25). Cluster membership was influenced by CoD-SD (Cluster II) and CoD-N (Cluster III) (Table 5.26).

| Cluster | Burial Type | Case |
|---|---|---|
| I | ——— | 1,-8,10-29,30, 32-39,43,44,46,47,48,49,51,54,55,56,57,58,59, 60,61,63,65,66,67,69,71,73,74,75,76,77,78,80,81,82,83 |
| II | Norm | 9,31,38,42,45,50,52,64,70,72,79 |
| III | Norm | 29,35,40,41,53,62,68 |

**Table 5.25** Cluster assignment for factor scores for Korea Data

| Cluster | Outlying Variable(s) |
|---|---|
| I | Cause of Death – Sickness/Disease |
| III | Cause of Death – Natural |

**Table 5.26** Variable(s) of outlying cases represented in cluster assignment for factor scores for Korea Data

These clustering results using factor scores suggest a structure based on cause of death variables. In contrast, clusters based on the 12 variables focused on body treatment (i.e. normative body positioning).

### 5.4.4.c K-means Clustering Results

The k-means clustering method was set to assign three clusters, representing normative, conflict friendly and conflict hostile burials using 12 of the 14 variables. Conflict neutral burials were not selected to be separated at this stage because many of the attributes are similar to the other conflict burials, and as such, will not be clearly separated; furthermore, the clustering method performed poorly at the four-cluster level. See Tables F.26-28 for the cluster assignments and the components of each cluster obtained.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Norm | 32,37,41,43,44,51,54,55,56,59,65,74,75,76,80,81,82,83 |
| II | Conflict | 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 21,22,23,24,25,26,27,28 |
| III | Norm | 29,30,31,33,34,35,36,38,39,40,42,45,46,47,48,49,50,52,53, 57,58,60,61,62,63,64,66,67,68,69,70,71,72,73,77,78,79 |

**Table 5.27** K-means cluster assignment for Korea Data

The method correctly assigned 100% of the conflict burials as one cluster. K-means further separated normative burials into two clusters based on the presence of a marker (Table 5.27). The cluster assignment defined three clearly separated clusters that did mirror the burials based on the presence or absence of ritual markers among normative burials.

#### 5.4.4.d Discussion

There was little difference in the results produced by hierarchical clustering and k-means clustering of the 12 variables, both performing well. The dataset was made up of easily differentiated cases between conflict and normative burials, and the test results corresponded with the types of burials that comprised the data; however, there some differences in the burial types (e.g. neutral and friendly burials) from the conflict data that none of the statistical techniques identified.

### 5.4.5 BALKANS DATA

The Balkans dataset consists of 119 cases, 31 from two conflict sites (one Croatian and one Bosnian), from the conflict in the Former Yugoslavia (1991-1995). The normative burials are comprised of 88 burials representing the three major culture groups of the region (Serbian, Croatian, and Bosniak) from the mid- to late 20$^{th}$ century. All of the 14 variables were used (see Appendix D.3.7 for abbreviations used to identify variables). See Appendix F Tables F.29-35 and Figures F.9-10.

The 12 graves from the two conflict period sites are graves located in non-descript areas, such as in the woods, the side of the road, or in a vacant field. All of the remains appeared to be unceremoniously placed in the grave, in all manner of directions and often commingled. There was evidence of executions having taken place at the site of some of the graves from the presence of spent cartridge casings and bullets in and around the graves and as well as physical restraints. In addition, the graves were comprised of male and female civilians as well as male military personnel, some as young as 25 and others as old as 60 years of age. The graves did not have any normative ritual markers present, such as containers, grave goods, or markers. It would appear that from the body treatment and general lack of ritual markers that the graves were hostile burials during open hostilities.

### 5.4.5.a Factor Analysis Results

The factor analysis results for the Balkans data were similar to that of the results from both the Spanish and Korean datasets, with the same type of correlations identified. Factor analysis extracted four factors, which appeared to separate many of the normative attributes (e.g. CoD-SD and CoD-N, Clothing, and grave goods) from other variables that suggest conflict behaviour, including 'Cause of Death-Extra Judicial' and Miscellaneous Artefacts (see Table 5.28). Factor 1 represented 41.35% of the variance (See Table F.29). In addition, the high negative and positive loadings in Factor 1 suggest mutually exclusive types of behaviour, normative versus conflict.

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| STATUS | .676 | -.326 | .468 | |
| CONTAIN | .967 | | | |
| CODCR | -.467 | .315 | -.490 | |
| CODEJ | -.794 | -.188 | .428 | |
| CODSD | .249 | -.617 | -.400 | |
| CODN | .494 | .522 | .248 | |
| MUT | -.700 | .321 | -.434 | .345 |
| MARKER | .617 | .309 | | |
| CLOTHING | -.435 | .459 | .341 | |
| GG | .276 | .539 | .280 | |
| BODPOSIT | .896 | | | .215 |
| MISC | -.929 | | | -.188 |
| CEMTYPE | .650 | .294 | -.577 | |
| OBINTNT | -.126 | | .220 | .936 |

**Table 5.28** Factor analysis component assignment for Balkans Data (correlations that are .1 or less are not listed)

The correlation matrix (Table F.31) indicates high positive correlation scores for Container to Marker, Body Position, and cemetery type. Conversely, CoD-EJ, CoD-CR, Mutilation, and Miscellaneous Artefacts have high negative scores suggesting that a normative container would not be associated with either that type of cause of death or the presence of miscellaneous artefacts. This pattern extends to the other variables as well. For example, BodyPosition, which has a high negative correlation to CoD-EJ and Miscellaneous Artefacts, has a high positive correlation to Marker. Again, these results correspond with relationships one would expect between conflict and normative burial characteristics.

### 5.4.5.b Hierarchical Clustering Results

Similar to the Spanish results, the results from the between-group cluster analysis demonstrate a good structure, differentiating between normative and conflict burials using all 14 variables. The dendrogram (Figure F.10) illustrates the major division between the two broad types of burials (conflict and normative) based on cause of death. The distances between cases within the normative cluster are not as far as the distance in which the conflict cases are combined because the normative cases are similar, whereas, with the conflict cases there are some major variations (see Appendix H for individual case records). The conflict cluster was subsequently divided into groups separated by CoD-EJ versus CoD-CR, followed by the body position variable (see Table 5.30). The cluster membership (Table 5.29) at the three-cluster level separates the normative burials from the conflict burials, which in turn, are separated by country, Bosnia and Croatia (Clusters I and II respectively). Consequently, hierarchical clustering was able to separate the 'Neutral' burials from normative and Conflict Hostile burials based on Status and cause of death.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Neutral | 1,2,3,4,5,6,7,8,9,10,11,12 |
| II | Hostile | 13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29 |
| III | Norm | 30-119 |

**Table 5.29** Cluster assignment for Balkans Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, CoD-CR, Misc.Artefacts, Clothing, Mutilation |
| II | Civilian Status, CoD-EJ, Misc.Artefacts, Clothing |
| III | Civilian Status, CoD-N, CoD-SD, Clothing, Container, BodyPosition, NormCemtery, Marker, Grave Goods |

**Table 5.30** Variables represented in cluster assignment for Balkans Data

The hierarchical clustering based on factor scores differed greatly from clustering based on the 14 variables. This clustering method had very poor results separating normative versus conflict burials, with mixed cluster assignments among the conflict burials. The dominant variable was cause of death in determining cluster assignment (Table 5.32). Fifteen of the conflict burials (58%) make-up Cluster I. Cluster II was comprised of 13 conflict burials (42%) and 100% of the normative cases (88). The remaining conflict burial (case 29 from the Croatia site) alone was assigned to Cluster III (Table 5.31).

| Cluster | Burial Type | Case |
|---|---|---|
| I | ---- | 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16 |
| II | ---- | 13,17-28,30-119 |
| III | Hostile | 29 |

**Table 5.31** Cluster assignment for factor scores for Balkans Data

| Cluster | Outlying Variable(s) |
|---|---|
| I | Military Status, CoD-Combat Related |
| III | Obscuration |

**Table 5.32** Variable(s) of outlying cases represented in cluster assignment for factor scores for Balkans Data

### 5.4.5.c K-means Clustering Results

Using all of the 14 variables, the k-means clustering method was set to assign three clusters, because the clustering method performed poorly when identifying the fourth burial type. Therefore, a forth burial type was not selected to be separated at this stage because many of the attributes are similar to the other conflict burials, as such, not properly separating the burials (Table 5.33). See Tables F.33-35 for the cluster assignments and the components of each cluster obtained.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 1-31 |
| II | Norm | 33,34,41,43,45,52,57,59,61,63,65,67,68,73,75,76,77,85,89,94,97,98,99, 101,102,103,104,105,106,107,108,109,110,111,112,117 |
| III | Norm | 32,35,36,37,38,39,40,42,44,46,47,48,49,50,51,53,54,55,56,58,60,62,64,66, 69,70,71,72,74,78,79,80,81,82,83,84,86,87,88,90,91,92,93,95,96,100,102, 103,106,107,109,113,114,115,116,118,119 |

**Table 5.33** K-means cluster assignment for Balkans Data

As with the Korean results, the method correctly assigned 100% of the conflict burials as one cluster. K-means further separated normative burials into two clusters based on the presence of a grave marker. The cluster assignment defined three clearly separated clusters based on the presence or absence of ritual markers among normative burials. Consequently, k-means allowed one variable to dominate other, equally important variables, at the expense of properly defined clusters. Overall, the k-means clustering was not able to identify the different conflict burials (neutral and hostile) present.

#### 5.4.5.d Discussion

Both clustering methods using the 14 variables produced differentiation of normative versus conflict burials, though the foundation variables of the clusters were different (status and cause of death). The clusters that emerge are primarily based on cause of death. The factor score based hierarchical clustering results are badly skewed by the separation of one site (Bosnia), 10% of total burials, from the other cases (one conflict and three normative sites). This separation was based on a different cause of death. The most accurate, and clearly defined, results are those based on between-average clustering of the 14 variables; it was the only method when testing the Balkans data to separate the burials according to the burial model by separating the neutral burials from the other burial types.

### 5.4.6 19TH CENTURY NORTH AMERICA (Snake Hill, Antietam, Ox Hill, and Little Big Horn)

The data representing 19th century North American consists of 91 cases, of which 52 are from four conflict sites from conflicts in North America (1812, 1861-64, 1876). The remaining 34 cases represent normative burials and are from a Methodist cemetery in Ontario from the early to mid-19th century. Twelve of the 14 variables (see Appendix D.3.7 for abbreviations used to identify variables) were used because two had zero variance (CoD-EJ and Obscuration). See Appendix F Tables F.36-42 and Figures F.11-12.

The 52 graves from the four conflict period sites are single graves located in a vacant field (the two American Civil War sites and the Little Big Horn site) or on the grounds of a military fort (Snake Hill site). All of the remains appear to be carefully placed in the grave. This pattern of behaviour does not include the cases from the Little Big Horn site, which were of elements left behind during reburial periods, and as such, were in all manner of directions and often disarticulated. Furthermore, primarily in the case of the Little Big Horn burials, there was evidence of hostilities having taken place at the site of the graves from the presence of spent cartridge casings and bullets in and around the graves. It would appear that from the presence of body treatment and containers, and in some cases markers, that the graves were friendly burials behind the front lines or after the cessation of hostilities.

### 5.4.6.a Factor Analysis Results

Factor analysis extracted three factors, which appeared to separate the two types of 'normative' causes of death and grave goods from all the other variables. A second factor comprised of characteristics representing normative behaviour (Table 5.34). In addition, the high negative and positive loadings in Factor 1 suggest mutually exclusive types of behaviour and it represented 41.43% of the variance (see Table F.36).

| | Component | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | .890 | -.302 | |
| CONTAIN | .891 | -.102 | |
| CODCR | -.906 | .213 | |
| CODSD | .520 | -.320 | .385 |
| CODN | .191 | | -.823 |
| MUT | -.556 | | |
| MARKER | -.589 | -.595 | |
| CLOTHING | -.581 | .542 | .144 |
| GG | .193 | | .476 |
| BODPOSIT | .558 | .599 | |
| MISC | -.718 | | -.149 |
| CEMTYPE | .633 | .598 | |

**Table 5.34** Factor analysis component assignment for 19th Century Data (correlations that are .1 or less are not listed)

The correlation matrix (Table F.38) had similar results to the Korea data results. The matrix indicates high positive correlation scores for Container to Status, Cemetery Type, and Body Position. Status was highly correlated to the different causes of death, be it a high positive score to CoD-SD, or a negative score to CoD-CR. However, some characteristics that traditionally may not be associated with normative burials, (such as high negative correlations between Container and

Miscellaneous Artefacts) do appear in 2% of the burials. These results are consistent with correlations one would expect between normative and conflict burial characteristics.

### 5.4.6.b Hierarchical Clustering Results

The results from the between-groups method cluster analysis demonstrate a good structure, differentiating between normative and conflict burials using 12 variables. The dendrogram (Figure F.12) illustrates the general division between the two broad categories of burials (conflict and normative). However, there is a small cluster within the larger 'normative' cluster comprised of three conflict burials (Ox Hill) and five normative burials. This smaller cluster is at the point where the 'normative' cluster and the 'conflict' cluster meet. The three Ox Hill (cases 47, 48, and 50) (see Appendix H for individual case records) burials do not have an assigned cause of death hence placement closer to the larger, normative cluster, but still close to the conflict cluster. The cluster membership at the three-cluster level separates these same three burials from conflict (Cluster I) and normative burials (Cluster III) (see Tables 5.35 and 5.36). Additionally, there is the anomaly of Cluster II, which is comprised of only one case (case 6 from the Custer dataset). This case did not have evidence of clothing, a marker, or miscellaneous artefacts; in fact, the only characteristic it possessed was CoD-CR.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Friendly | 1,2,3,4,5,7-46,49,51,52 |
| II | Friendly | 6 |
| III | Norm | 47,48,50,53-91 |

**Table 5.35** Cluster assignment for 19th Century North America Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, CoD-CR, Marker, Mutilation, Misc.Artefacts, Clothing |
| II | Military Status, CoD-CR |
| III | Civilian Status, CoD-SD, Clothing, Container, BodyPosition, NormCemtery |

**Table 5.36** Variables represented in cluster assignment for 19th Century North America Data

In addition to clustering burials based on the 12 variables, factor scores were calculated for all the burials. These results were then processed using cluster analysis. The clustering based on factor scores was quite different from clustering based on the 12 variables. Furthermore, this clustering method performed very poorly based on identifying normative versus conflict burials. All of the 52 conflict burials and 87% of the normative cases (34) were assigned to Cluster I, with the remaining 13% of normative cases being assigned to Clusters II and III. CoD-N and the presence of grave goods influenced cluster membership at this stage (see Tables 5.37 and 5.38).

| Cluster | Burial Type | Case |
|---|---|---|
| I | Friendly | 1-52,55,56,57,59-79,81,82,83,84,85,86,87,88,90,91 |
| II | Norm | 53,58,80 |
| III | Norm | 54,89 |

**Table 5.37** Cluster assignment for factor scores for 19th Century North America Data

| Cluster | Outlying Variable(s) |
|---|---|
| II | Cause of Death – Natural |
| III | Grave Goods |

**Table 5.38** Variable(s) of outlying cases represented in cluster assignment for factor scores for 19th Century North America Data

Furthermore, this clustering based on factor scores focused on the differences in the normative burials, whereas the clustering of the 12 variables singled out the differences in the conflict burials. These results clustering using factor scores suggest a structure based on cause of death variables. In contrast, clusters based on the 12 variables focused membership on the ritual markers (i.e. Marker, grave goods, and Miscellaneous Artefacts).

### 5.4.6.c K-means Clustering Results

Again, the k-means clustering method was set to assign three clusters, representing normative, conflict friendly and conflict hostile burials using 12 of the 14 variables. Conflict neutral burials were not selected to be separated at this stage because many of the attributes are similar to the other conflict burials, as such, will not be clearly separated. As with the other k-means clustering at the four-cluster lever, the method performed poorly. See Appendix F Tables F.40-42 for the cluster assignments and the components of each cluster obtained.

| Cluster | Burial Type | Case |
|---|---|---|
| I | Norm | 53-91 |
| II | Friendly | 20-52 |
| III | Friendly | 1-19 |

**Table 5.39** K-means cluster assignment for 19th Century North America Data

The method correctly assigned 100% of the normative burials to one cluster. K-means had similar results for correctly separating the conflict burials with 3% of the conflict burials incorrectly assigned (Table 5.39). The three burials did not have an identifiable cause of death. While the cluster assignment defined three clearly separated clusters that did mirror the burials, the characteristics used to define the clusters were themselves, not close to what was actually present in the burial. Moreover, cluster assignment was based on the presence of the cause of death variable (which was not always identified) at the expense of three other variables (Status, Miscellaneous Artefacts, and Cemetery Type). Consequently, k-means allowed one variable to dominate other, equally important variables, at the expense of properly defined clusters.

### 5.4.6.d Discussion

Both clustering methods using the 12 variables produced good differentiation of normative versus conflict burials, though basing the clusters on different variables. The clusters that emerge are primarily based on status or the cause of death. The factor score based clusters are badly skewed by the three (3% of total) cases assigned a different cause of death and the two (2% of total) cases based on the presence of grave goods. The most accurate, and clearly defined, results are those based on between-average clustering of the 12 variables. However, since all of the conflict burials were 'Friendly', all of the methods would undoubtedly identify them as such.

### 5.4.7 MEDIEVAL ENGLAND DATA

The Medieval England data consists of 73 burials, 38 from the Towton conflict site. Thirty-five burials from the church and Priory of St Andrew, Fishergate, York from the early to mid-15th century are used as the comparative normative burials. There was a small amount of variation among the variables; this meant that fewer variables were used to test the burials. Only ten of the 14 variables were used because four variables had zero variance (CoD-SD, CoD-EJ, Clothing, and Obscuration). See Appendix F Tables F.43-48 and Figures F.13-14.

The mass grave from the conflict period site was located under the foundation of Towton Hall. All of the remains appeared to be unceremoniously placed in the grave, in all manner of directions and often commingled. The grave did not have any normative ritual markers such as containers, grave goods or markers present. It would appear that from the location of the grave (not a normative location for burial), body treatment, and general lack of ritual markers that the graves were hasty burials shortly after the cessation of hostilities and/or death.

#### 5.4.7.a Factor Analysis Results

Factor analysis extracted four factors (Table 5.40), with two factors representing the greatest amount of variance among the burials. The variables Status and Cemetery Type had very high positive loadings in Factor 1, which represented 37.57% of the variance (see Table F.43). A second factor comprised of characteristics with moderately high factor loadings for grave goods and Mutilation, representing secondary variation, which accounted for an additional 12.17% variance.

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| STATUS | .946 | | | |
| CONTAIN | .179 | .104 | -.262 | .712 |
| CODCR | -.808 | .287 | | |
| CODN | .179 | .104 | -.262 | -.712 |
| MUT | -.707 | .426 | | |
| MARKER | .104 | -.363 | .766 | |
| GG | -.164 | .740 | .432 | |
| BODPOSIT | .859 | .397 | | |
| MISC | -.191 | | -.308 | |
| CEMTYPE | .913 | .282 | .115 | .000 |

**Table 5.40** Factor analysis component assignment for Medieval Data (correlations that are .1 or less are not listed)

The correlation matrix (Table F.45) followed the pattern in correlations that were evident from the other sites. There were high positive correlation scores for Status to Cemetery Type and BodyPosition, while a having a negative correlation to CoD-CR and mutilation (see Appendix D.3.7 for abbreviations used to identify variables). There is a pattern of variables representing normative behaviour with high negative relationships to variables representing non-normative behaviour. These results are consistent with associations one would expect between conflict versus normative burial characteristics.

### 5.4.7.b Hierarchical Clustering Results

The results from the between-group method cluster analysis demonstrated moderate success in differentiating between normative and conflict burials using ten variables (Table 5.42). The dendrogram (Figure F.14) broadly separates normative from conflict burials; however, there is a small cluster of seven conflict burials within the larger 'normative' cluster (see Appendix H for individual case records). In addition, three normative burials, which have some characteristics of conflict burials (CoD-CR, Mutilation), are placed in the larger 'conflict cluster'. The cluster membership (Table 5.41) at the three-cluster level broadly separates normative from conflict with the same seven conflict burials assigned separate cluster membership (Cluster II). In addition, four normative burials (cases 40, 71-73) were assigned to the conflict cluster (Cluster I).

| Cluster | Burial Type | Case |
|---|---|---|
| I | Conflict | 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,29, 30,31,32,33,34,35,36,37,38,40,71,72,73 |
| II | — | 22,23,24,25,26,27,28 |
| III | Norm | 39,40,41,42,43,44,45,46,47,48,49,51,52,53,54,55,56,57,58,59,60, 61,62,63,64,65, 66,67,68,69,70 |

**Table 5.41** Cluster assignment for Medieval Data

| Cluster | Variable(s) |
|---|---|
| I | Military Status, CoD-CR, Mutilation, Misc.Artefacts |
| II | Military Status, CoD-CR, Mutilation, Grave Goods |
| III | Civilian Status, CoD-N, Container, BodyPosition, NormCemtery |

**Table 5.42** Variables represented in cluster assignment for Medieval Data

In addition to clustering burials based on the 10 variables, factor scores were calculated for all the burials. These results were then processed using cluster analysis. The clustering based on factor scores was quite different from clustering based on the 10 variables. Again, this clustering method performed poorly based on identifying normative versus conflict burials. Three clusters were defined with 100% of the conflict burials (38) and 94% of the normative cases (33) assigned to Cluster I, with the two normative cases being assigned either to Cluster II or III (Table 5.43). The presence of Grave Goods or Container determined cluster membership (Table 5.44).

| Cluster | Burial Type | Case |
|---|---|---|
| I | —— | 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35,36,37,38,39,40,42,43,44,45,46,47,48,49,50, 51,52,53,54,55,56,57,59,60,62,63,64,65,66,67,68,69,70,71,72,73 |
| II | Friendly | 41 |
| III | Friendly | 61 |

**Table 5.43** Cluster assignment for factor scores for Medieval Data

| Cluster | Outlying Variable(s) |
|---|---|
| II | Container |
| III | Grave Goods |

**Table 5.44** Variable(s) of outlying cases represented in cluster assignment for factor scores for Medieval Data

### 5.4.7.c K-means Clustering Results

As with all the site tests, the k-means clustering method was set to assign three clusters, representing normative, conflict friendly and conflict hostile burials. Ten of the 14 variables created the three clusters. Conflict neutral burials were not selected to be separated at this stage because many of the attributes are similar to the other conflict burials, and as such, will not be clearly separated. Clustering burial types at the four-cluster level did not perform well, as with the other datasets. See Appendix F Tables F.46-48 for the cluster assignments and the components of each cluster obtained.

| Cluster | Burial Type | Case |
|---|---|---|
| I | ---- | 40,71,72,73 |
| II | Norm | 39,41-57, 59,-70 |
| III | Conflict | 1-38 |

**Table 5.45** K-means cluster assignment for Medieval Data

The method assigned 89% (31 cases) of the normative burials to Cluster II (Table 5.45). The remaining three (11%) normative burials, and one conflict burial, are assigned to Cluster I. Three of the four burials had combat related cause of death, with one burial not having an identifiable reason for Cluster I assignment. However, two (5%) conflict burials were assigned Cluster II membership. The remaining 35 (92%) of the conflict cases form Cluster III. The cluster assignment defined three clearly separated clusters that did mirror the burials.

### 5.4.7.d Discussion

None of the methods applied produced clear clustering of the burials. There were variations in the burials among the normative burials that had characteristics similar to conflict burials and as such, were identified as conflict burials. This incorrect identification illustrates a weakness in the recognition of burial types because it was not able to differentiate some of the smaller differences in a select few normative burials with conflict variables. In addition, similar to the results for the Balkans burials, the factor results give a better indication of the relationships between variables.

## 5.5 Discussion

The first stage of analysis of such a complex dataset was performed using traditional multivariate statistical methods. Through factor, cluster, and k-means analysis, it became possible to determine the facility of specific variables in the analysis; many of the extraneous variables were replaced or removed entirely. These variables did not contribute to the overall definition or understanding of the behaviour of the burial nor did they exhibit a high level of distinction to warrant continued use.

It is important to note here that some of the more specific variations in behaviour, those described above as extraneous, may not contribute to an understanding of burials within the parameters of the burial model presented here, which deals with specific burial events at small sites. However, they do have the potential to be analysed at sites with much larger datasets, such as large cemeteries or mass burials or intra-site studies of burial sites across a conflict area.

Factor analysis was especially effective in identifying redundant variables. It indicated variables that were so highly correlated that they represented the same behaviour. Additionally, examination of the factor analysis correlation matrix suggests significant patterns in the data. The Status correlation remains consistent for all causes of death at the site level and at the inter-site level. There were other strong correlations among the variables at all levels of analysis; however, the correlations that emerged were expected to appear, such as high correlations between Container and normal body positioning.

Overall, the results of the clustering techniques were generally encouraging with regards to separating burial types at a broad level (normative versus conflict); however, in identifying the conflict burial types, the results were mixed. The agglomerative hierarchical clustering dendrogram offered the most effective method of analysing the resulting clusters and the levels of similarity between cases. This gave a clearer picture of the cases than just cluster assignments.

The results indicated that information about burials could be extracted with the three methods employed (factor, hierarchical and k-means clustering analyses). The use of the three methods applied in this research can therefore be considered useful as analytical tools in any future study of conflict burial sites.

After the refining of the data to eliminate redundant variables, they were used to test the model. The model identified four distinct burial types (normative, friendly, neutral, and hostile). Most of the more general aspects of the burial characteristics of each of the three conflict burial types were quite similar across the different datasets. The results also suggest that there was little variation in the three conflict burial types across different types of conflict, such as civil war or isolated battles, within each of the different time periods that creates continuity in conflict burial behaviours, despite these differences in time and place.

The results here are typical of statistical studies of mortuary phenomena with qualitative aspects. Previous methods used by other analysts in the past expose patterns at too coarse a resolution (i.e. they lack the detail needed) to determine what one wants them to determine and they cannot deal with variables such as meaning and intent. Pader (1982: 87) comments on this issue of attributing meaning and suggests that "no statistical procedure is powerful enough to cope thoroughly with the problem of an attribute changing its meaning, depending upon the context". Hodson integrated qualitative analysis and quantitative analysis in attempting to overcome the issue of attribute meaning (1990: 23), while Shepherd applied an entirely qualitative based approach to studying mortuary behaviour (1999: 33). McHugh (1999) offered a multi-dimensional approach when dealing with weaknesses in multivariate techniques when applied to mortuary data. He applied three methods of cluster analysis (Ward's, averaged Jaccard, and monothetic divisive) and PCA to compensate for presumed weaknesses in any of the methods, to provide at least one technique that would produce informative results (McHugh 1999: 96-97; 106). Consequently, different techniques might be necessary to provide answers for different questions of the data. The mixed results from the multivariate statistics indicate that the multidimensionality of conflict burial data needs a new methodology to explore the data. A new methodology based on non-linear perspectives that will accommodate both quantitative and qualitative information.

# CHAPTER 6 APPLICATION AND RESULTS OF THE SOM NEURAL NETWORK

## 6.1 INTRODUCTION

Uncovering structure in data is the aim of clustering methods. Neural networks offer a non-linear alternative to traditional multivariate techniques in the study of mortuary behaviour by classifying both quantitative and qualitative data and providing visual outputs.

The SOM is a visually dependent method of illustrating the results of the neural network. Here, it was applied to three levels of data: All Data; All Conflict Data; and individual sites (normative and conflict data), which are used for classification and to identify correlations between variables. The variables are the same as those used in the multivariate techniques discussed in Chapter 5.

## 6.2 REVIEW OF NEURAL NETWORK ANALYSIS

The main application of the SOM in this context was to group similar cases into clusters – a goal consistent with traditional multivariate clustering methods. The primary interpretive goal was to test if neural networks could identify the models' burial types from the variables that relate to body treatment.

As the SOM neural network results are presented as images, a description of the main components of SOM results, as well as the visualisation and interpretation processes, follows in order to explain how the results were interpreted here.

The SOM application in MATLAB automatically defines a map space (dimensions) based on the input data. While other SOM software allows the user to define the dimensions (e.g. a 2 x 2 map creates a four cluster map), the software used here defines the map space, and the number of hexagons that make-up the map is automatically based on the input data. For example, the Medieval data created a map 9 x 5, whereas the map dimensions for the Balkans dataset is 11 x 5, larger dimensions for a larger amount of data. These dimensions determine not only the number of clusters, but also the distance between clusters derived by the SOM (Kiang 2001: 162). The data exploration tool presented in this chapter allows visualization and analysis of mortuary data. This method can be used for pattern recognition and clustering of data without knowing the class memberships of the input data map space. This not only limits *a priori* assumptions on the data, but also reduces the occurrence of creating more clusters than are actually represented in the data (Simula et al. 1999: 88).

### 6.2.1 Visualisation

There are several different forms of visualisation for the three types of analysis: cluster structure, component (variable) correlations, and visualisation of the data on a map. There are also combinations of features that can be represented on one map. The visualisation and interpretation methods used here are based on Simula et al. (1999), Siponen et al. (2001), Vesanto (1999, 2000), and Vesanto and Alhoniemi (2000). In addition to the projection methods described below, there are also a number of 3-dimensional methods and colour coding methods that can be used by the SOM.

**U-Matrix**

The unified distance matrix (u-matrix) developed by Ultsch (1993) is probably the most commonly used component of the SOM. The u-matrix displays the structure of the SOM by visualising the distances between the weights of vectors (cases) of neighbouring units. A grey-scale is used here to demonstrate the distance between units, where the lighter the colour, the smaller the relative distance and hence the greater the similarity. A black band of units is developed when cases are distant in weight, hence the cases being very dissimilar. The location of cases within and the corresponding make-up of the u-matrix are defined by the values of the component planes (variables).

Additional information can be added on top of the map representation. For example, the best-matching unit (BMU) can be labelled on the u-matrix. This technique identifies the unit (cases) that indicates the response of each map unit. A related technique uses spots of different sizes to represent how many cases (hits) there are - the larger the spot is, the larger the number of hits. If the 'hit' circle is smaller than the hexagon, the BMU is closer to the data sample than to its neighbour (Vesanto 1999: 118). This identification (highlighting) of the BMU uses colour. Another identification technique using colour identifies individual, or groups, of cases in the u-matrix.

**Component Planes**

The aim of interpreting the component planes is to identify which components are important to each cluster. Component plane (variable) representation displays the value of each variable on the map. A grey-scale is used to illustrate the component value, where the lighter the colour is, the smaller the relative component value (Simula et al. 1999: 91).

By analysing the component planes, correlations between variables are visually apparent. Correlations between variables are represented as similar patterns in positions of the colouring in the component planes. Additionally, the component planes can be reorganised according to the place corresponding to the BMU of the respective row. This produces a figure where highly correlated variables are represented as closer to each other, rather than as the order in which they are listed in the file (Alhomieni 2002: 34). Finally, combinations of selected components can be extracted to create a map of the combined values. This cumulative visualisation can be used to identify the dominant variables and illustrate how the variables relate to each other, as well as the impact of the combined planes on the overall u-matrix.

One issue that may be confusing is the value of distance in the u-matrix and the value of each component plane. The scale indicated in the u-matrix describes the distance between units, whereas the value of the component plane describes the value of the variable's influence. For example, a high value in the u-matrix means a greater distance between units, but a high value in the component plane means a highly influential variable.

**Other Distance Matrices**

Distance between units can also be visualised using a marker size matrix (d-matrix). As with the u-matrix, the distances of each map unit are calculated. Instead of using colour or shading to illustrate distance the markers vary in size and/or shape

(Vesanto 1999: 8). The larger the marker is, the greater the similarity between corresponding units.

## 6.3 Self-Organizing Map Results

The data were tested in three basic samples: all data; all conflict data; and individual sites. Site data consist of conflict and normative data representing an area of study (for example, all Spanish data tested as one site). The SOM method was applied to identify clusters and correlations between variables. The projections (maps) created by the SOM are non-linear, two-dimensional representations of the topology of the input vectors (cases).

The analysis at the intra-site level, All Data and All Conflict data, helps to identify deviations from the norm and broad patterns common to conflict period burials. This fits with the aim of the analysis of individual sites, which was to identify regional or cultural patterns in mortuary behaviour as well as to differentiate between normative and conflict burials. Furthermore, analysing data at the site level helps to identify patterns common to particular types of conflict. Intra-site analysis also removes 'noise' that may be in the larger, more complex, dataset

### 6.3.1 All Data

The same data discussed in Chapter 5 make up all the data used with the SOM, which are 434 cases that include the conflict and normative cases ranging from the medieval period (1461) to modern times (1995). Of these 434 cases, 183 individuals in 89 graves comprise the conflict portion of the data, and 251 individuals in single graves are the comparative normative data[1]. All 14 variables (see page 159 for abbreviations) were used at this level since none of the variables had zero variance.

[1] Abbreviations used as labels to identify sites

| | | | |
|---|---|---|---|
| Ant | Antietam, Maryland, USA | Snake | Snake Hill, Fort Erie, Ontario |
| Custer | Little Big Horn Cemetery, Montana, USA | Ox | Ox Hill, Virginia, USA |
| Towton | Towton, Yorkshire, UK | Korea | Kujan, North Korea |
| SpnB | Benegiles, Zamora, Spain | SpnO | Olmedillo de Roa, Spain |
| SpnV | Vadoncondes, Burgos, Spain | SpnVil | Villaviciosa, Asturias, Spain |
| Bosnia | Bosanski Petrovac, Bosnia-Herzegovina | Croat | Pakračka Poljana, Croatia |
| SerbN | Tenkovo, Serbia | CroatN | Slovanski Samac, Croatia |
| BosN | Ricica, Bosnia-Hercegovina | SpnNrm | Villanueva, Castille, Spain |
| Skorea | Sam Jong Don Village, S Korea | Ynktn | Yankton, SD, USA |
| Prspct | Prospect Hill, Ontario, Canada | Fisher | Fishergate, Yorkshire, UK |

Two types of maps were created to identify the burial types: u- and d-matrix clustering of the burial types (Figures 6.1 and 6.2); and the values of the component (variable) planes (Figures 6.5, 6.6, 6.7, 6.8, and 6.9). The first of these maps define clusters based on the 14 variables. The distances (dissimilarity) between cases in and between clusters indicate which cases have the highest value for the corresponding cluster and illustrate values (influence) of variables and correlations between variables. Additional maps with extracts of features (Figures 6.3 and 6.4) are used to highlight the distinctions between the cases.

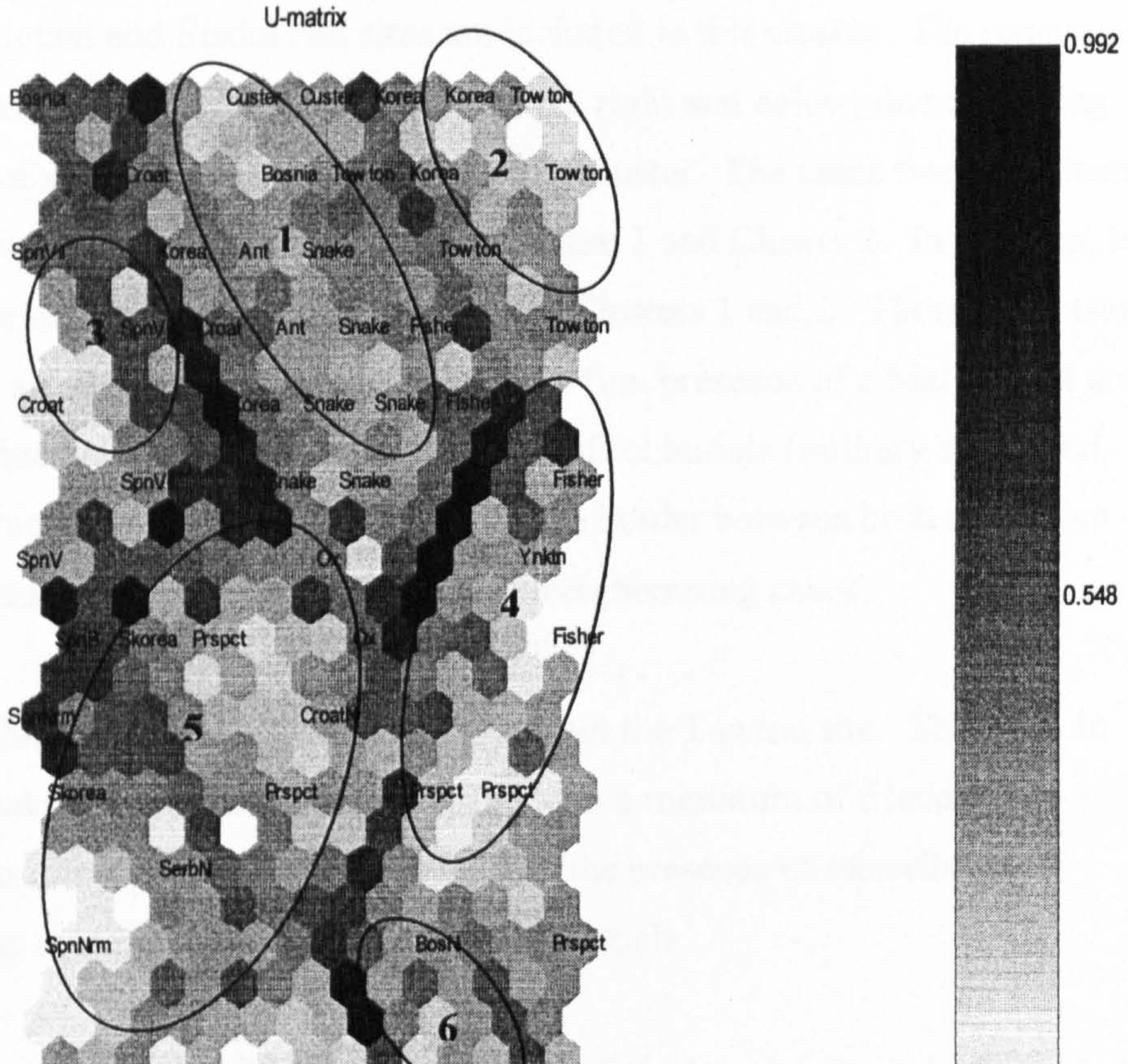


**Figure 6.1** U-matrix for All Data (visually defined clusters circled)

## U-matrix

The unified distance matrix (u-matrix) is a low-level map that illustrates the distance or dissimilarity between units (cases) by the use of shading. The value bar to the right of the projection indicates the value of the shading – the lighter the colour, the lower the distance score, and the more similar the cases.

The general u-matrix of the SOM of all the data is shown in Figure 6.1. The clustering splits the SOM into two (roughly upper and lower) general parts, normative versus conflict burials, based on cemetery type. These two parts are then further divided into six smaller clusters, which identify subtle variations in both normative and conflict burial behaviour, as well as singling out cases that have attributes of both general types of burial. In addition, there are a number of cases that are not members of a cluster. The clusters and their descriptions are shown in Table 6.1. See Appendix H for individual case records.

Cluster 1 corresponds to friendly conflict burials with a high degree of ritual markers. Antietam and Snake Hill sites are included in this cluster. The remaining cases from these two sites border Cluster 1 to the right and below, demonstrating some degree of similarity to the cases within the cluster. The cases from the Custer and Korean sites are on the border between Cluster 1 and Cluster 2. In addition, two cases from the normative Fishergate site border Clusters 1 and 2. These two cases contain some aspects found in normative burials (i.e. presence of a Marker and grave goods, and a location within a cemetery) and conflict burials (military status and CoD-CR), which therefore places them along the border between both normative and conflict clusters, indicating distance from neighbouring cases.

The second cluster (Cluster 2) includes cases from the Towton site. The cases in this cluster make up a friendly conflict burial with a minimum of friendly characteristics. The cases are divided based on the presence of miscellaneous artefacts being associated with some of the individuals.

Cluster 3 is made up of hostile burials from Croatia and Spain. Both of these sites are comprised of civilians killed extra-judicially without any normative grave goods or markers. In addition, the cases that are represented in this cluster also have a high rate of miscellaneous artefacts. These differences from the other conflict burials are noted by its distance or dissimilarity as indicated by the roughly defined row of very dark cases between Cluster 3 and 1.

Cluster 4 is comprised of normative cases from Prospect Hill, Yankton, and Fishergate that are very similar to each other, with a minimum changes in the shading. Cluster 5 is made up of the remaining normative cases from Prospect Hill along with the Serb, Croat, Bosnia, South Korean, and Spanish normative burials. Most of the cases in these sites have examples of normative behaviour (i.e. presence of a container and a marker and normative body positioning).

The burials from the Ox Hill dataset separate Cluster 1 from Cluster 5. These cases contain some aspects found in normative burials (i.e. presence of a container and normative body positioning) and conflict burials (military status, CoD-CR, and miscellaneous artefacts), which therefore places them along the border between both normative and conflict clusters, indicating similarity, yet distance from neighbouring cases.

The sixth cluster highlighted in the bottom right-hand corner (Cluster 6) of the u-matrix is made up of normative burials from Bosnia. The cases are quite similar to each other with the dissimilarity increasing to the left from the cluster. This cluster, comprised of cases that are clearly separated from the other normative cases, is based on the absence of clothing.

Separating Cluster 1 from Cluster 4 is a band of cases that are distant (very dissimilar) from the clusters on either side – as represented by the solid black ravine that separates very different clusters. There is a second band of cases acting as a boundary between clusters, separating friendly conflict burials (Cluster 1) from the hostile burials of Cluster 3. In addition, not only are the cases within the band distant from the cases in the cluster, but are rather dissimilar from each other.

| **Cluster** | **Burial Type** | **Variable** |
|---|---|---|
| 1 | Friendly | Military Status, CoD-CR, Mutilation, Marker, |
| 2 | Friendly | Military Status, CoD-CR |
| 3 | Hostile | Civilian Status, CoD-EJ, Clothing, Misc. Artefacts |
| 4 | Norm | Civilian Status, CoD-SD, CoD-N, NormCemtery, Body Position |
| 5 | Norm | Civilian Status, CoD-SD, CoD-N, NormCemtery, Grave Goods, Clothing, Marker, Body Position |
| 6 | Norm | Civilian Status, CoD-SD, CoD-N, NormCemtery, Marker, Container, Body Position |

**Table 6.1** Cluster assignment for All Data. The cluster refers to areas marked on Figure 6.1

**D-matrix**

The d-matrix projection (Figure 6.2) is similar to the u-matrix in that it separates the normative burials from the conflict burials; however, there are fewer and smaller clusters than in the u-matrix. The map indicates that most units belong to one of three clusters, with some cases (represented by the small marker size) near the centre separating Cluster 3 from the others.

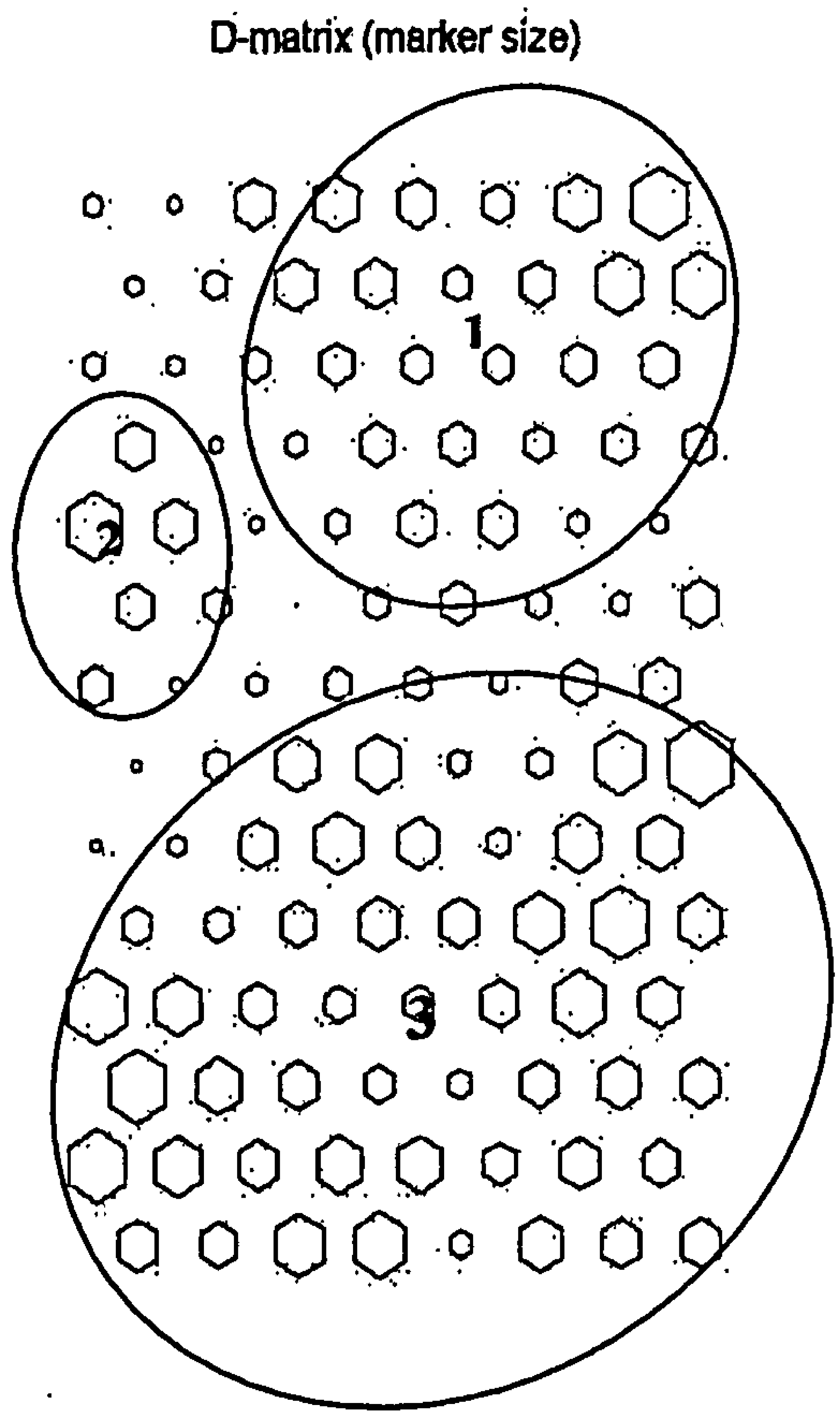


**Figure 6.2** Distance matrix or d-matrix (marker size) for All Data (visually defined clusters circled)

While this low-level projection is clearer than the u-matrix in identifying broad patterns in conflict burials, the slight differences in some of the burials is not as apparent in this map. In the d-matrix, the larger the marker size, the higher the similarity to its neighbour. For example, the cases represented by the markers that separate Clusters 1 and 2 are small, hence very distant (very dissimilar) to the cases in either Cluster 1 or 2.

**U-matrix and BMU**

Analysis of one high-level map with combined features, where the u-matrix and the best matching unit (BMU) properties were combined, resulted in a division of the burials into the same three types as above, e.g. normative cluster, conflict cluster, and the central (indeterminate) cluster. The size of the coloured hexagon is proportional to the value of the data in the corresponding unit. This feature pinpoints the case that represents the centre of each cluster, thereby indicating the ideal representation of the cluster. As well as identifying the BMU's for the map, the colour coding separates the different sites. Two maps with the combined features of the u-matrix, BMU, and colour coding were created to highlight different patterns.

The most obvious pattern in the first of the u-matrices (Figure 6.3) is the separation of red and green units, conflict, and normative burials, respectively. There are a few burials that do not fit. Three normative cases[2], cases 216, 217, and 218 from the Fishergate dataset (circled in black), are clustered in the larger conflict cluster. These three cases are soldiers (status based on age, sex, and associated artefacts) buried in a normative cemetery; however, the remains indicate mutilation (based on the multiple facial injuries sustained and the one instance of decapitation), they are not placed in a normative body position, and the cause of death was combat related.

A case from the Spanish Civil War (case 161 from the Bengilies site) is another example in Figure 6.3 of a burial exhibiting characteristics that are not normally associated with a particular burial (indicated by the arrow). While they are civilians buried in a multiple grave and the cause of death was extra-judicial, the location is a normative cemetery with a grave marker and grave goods.

[2] For the sake of clarity, the numbering system for cases here is the same as that used for the multivariate testing discussed in Chapter 5 and defined in Appendix H.

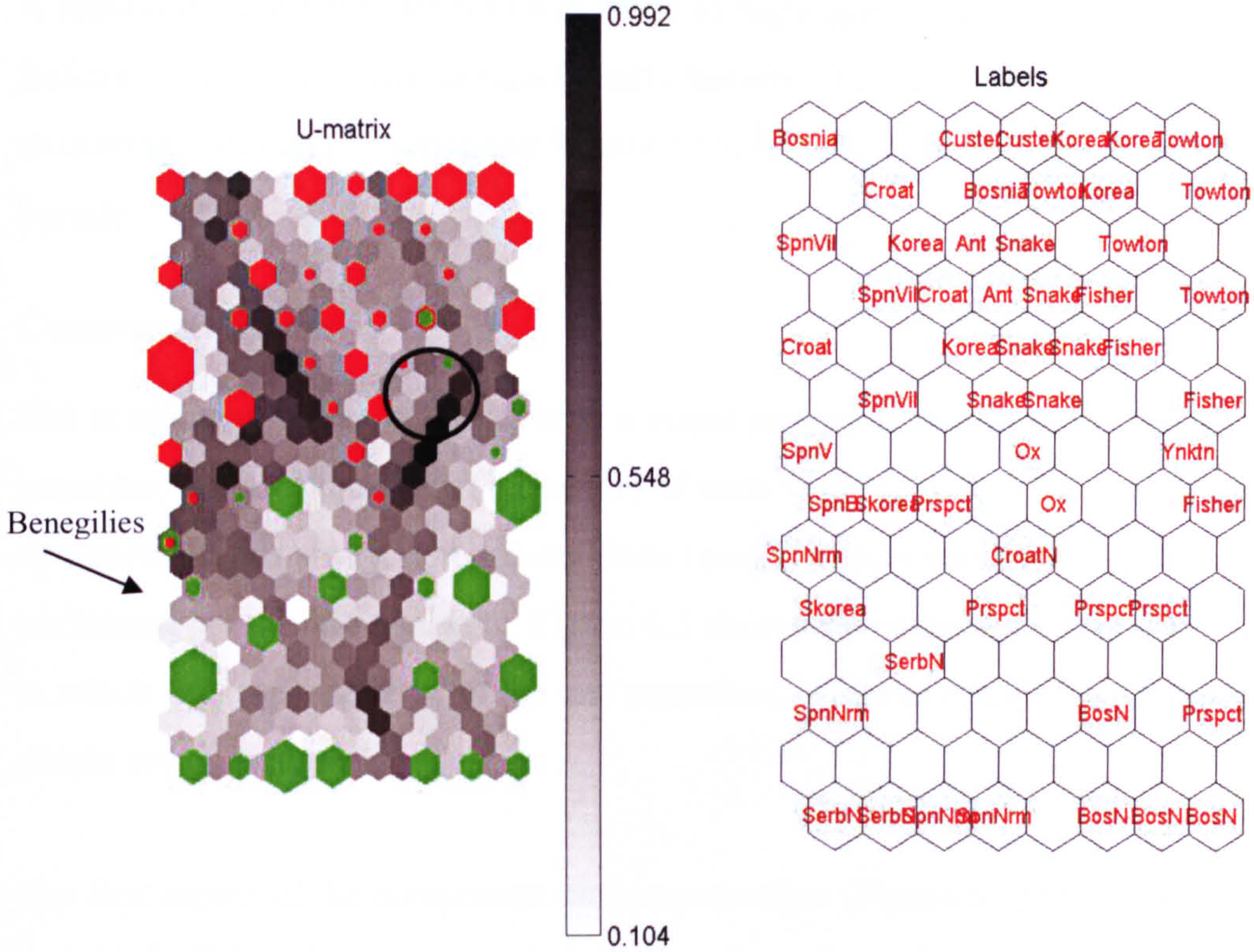


**Figure 6.3** U-matrix and corresponding labels and colour coded BMU's for All Data (Green: Normative; and Red: Conflict)

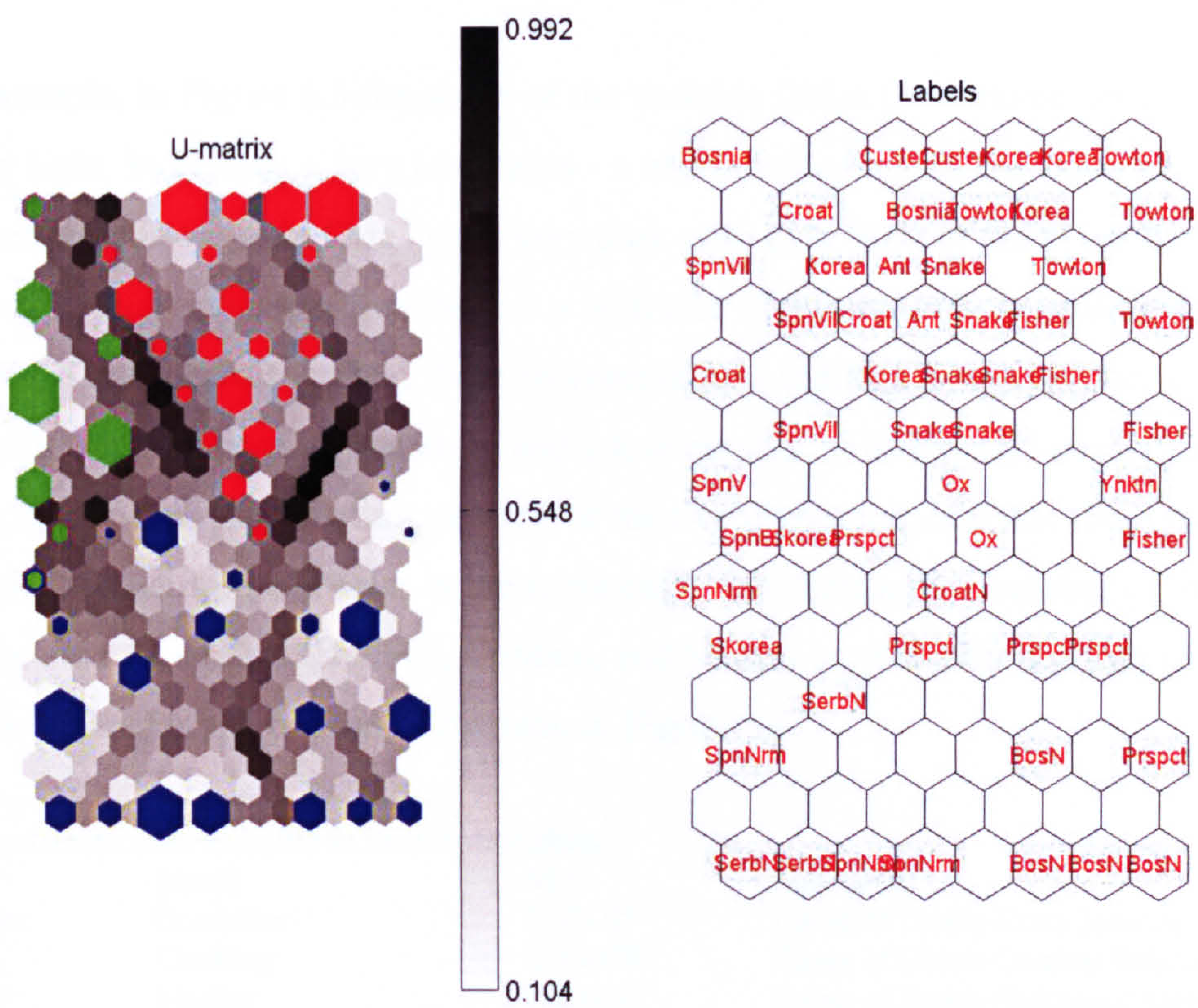


**Figure 6.4** U-matrix and corresponding labels and colour coded BMU's for All Data (Blue: Norm; Green: Balkans and Spain; Red: 19th Century North America, Korea, and Towton)

A second u-matrix (Figure 6.4) was made to highlight burials from Spain and the Balkans in order to focus on non-friendly burials. The cases illustrate that the clustering successfully separated hostile from friendly, and friendly from normative burials.

**Component Planes**

The component planes offer not only a visual representation of correlations between variables, but also the value (influence) of each variable within the overall map structure. In this study, component plane reorganisation was used together with traditional correlation analysis. Figure 6.5 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.6, the component planes are reorganised.

The first aspect of the component planes projection (Figure 6.5) is the value of each variable[3]. This value corresponds to the shading of the plane and value bar to the right of each component plane. The numerical value indicates the influence of each variable with a maximum range for any one variable between 0 and 1.

For example, in Figure 6.5 the shade of the variable ObInt (intentional obscuration) is very light, indicating a very low value - a maximum of 0.1 on the value bar. Conversely, the variable CemTyp is very dark with over 70% of the plane having a value of 1, thus indicating that there is a high rate of this variable as represented in the data. Considered together, these representations indicate a high number of individuals in a normative cemetery and a low number of intentional obscuration. In addition, the opposing shading patterns of the two planes indicate that these two variables would not be present in the same case. Furthermore, a number of the neighbours of CemTyp (BodPos, Contain, and Status) have similar shading patterns and are located at the bottom of the map in Figure 6.6.

[3] Abbreviations used as labels to identify variables

| | | | |
|---|---|---|---|
| Status | Status | Mut | Mutilation |
| Contain | Container | CoD-EJ | Cause of Death-Extra Judicial |
| Cloth | Clothing | CoD-CR | Cause of Death-Combat Related |
| Marker | Marker | CoD-SD | Cause of Death-Sickness/Disease |
| GG | Grave Goods | CoD-N | Cause of Death-Natural |
| Misc | Miscellaneous Artefacts | CemType | Cemetery Type (Norm) |
| BodPos | Body Position (Norm) | ObIntnt | Intentional Obscuration |

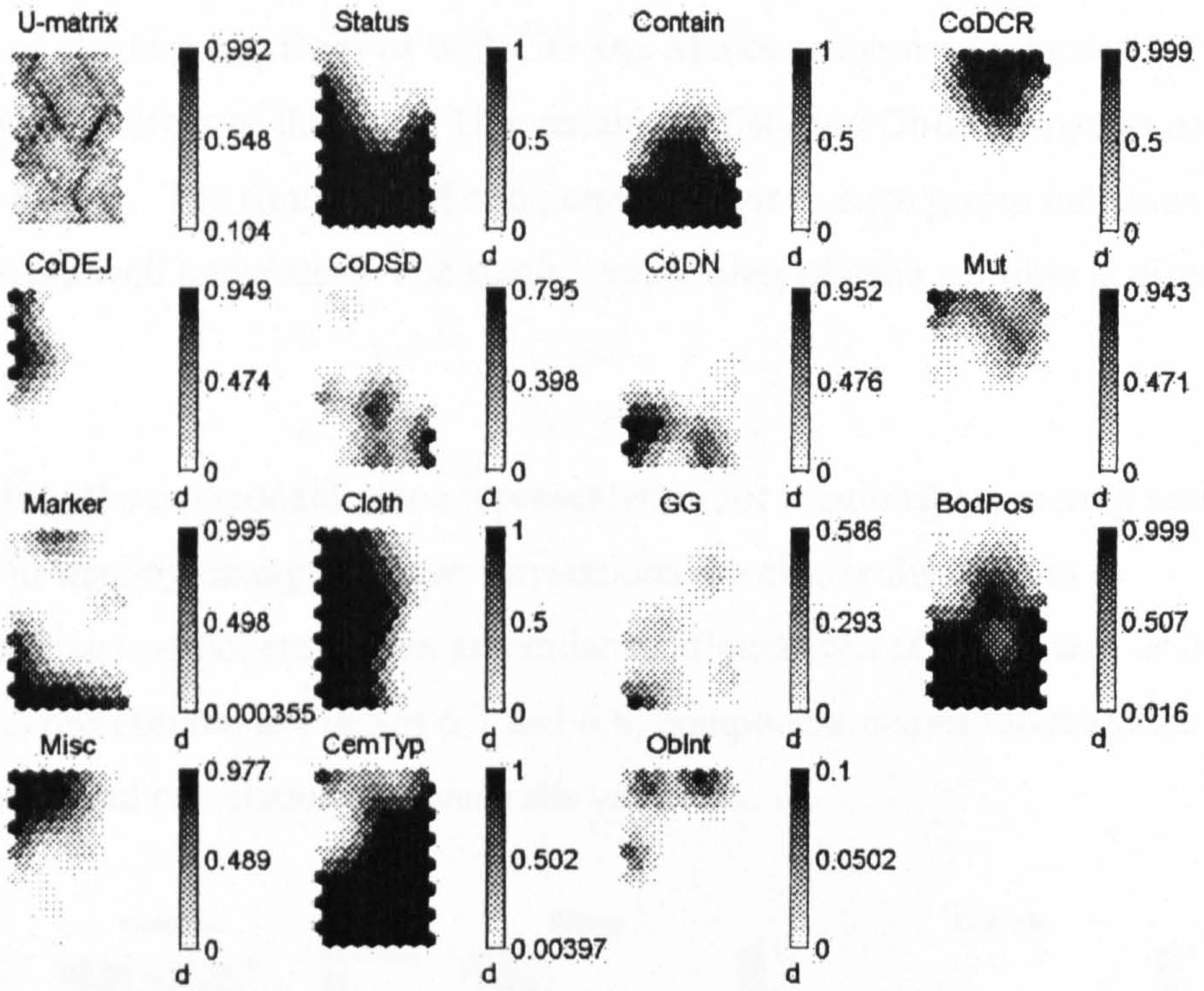


**Figure 6.5** U-matrix and component planes of all variables for All Data

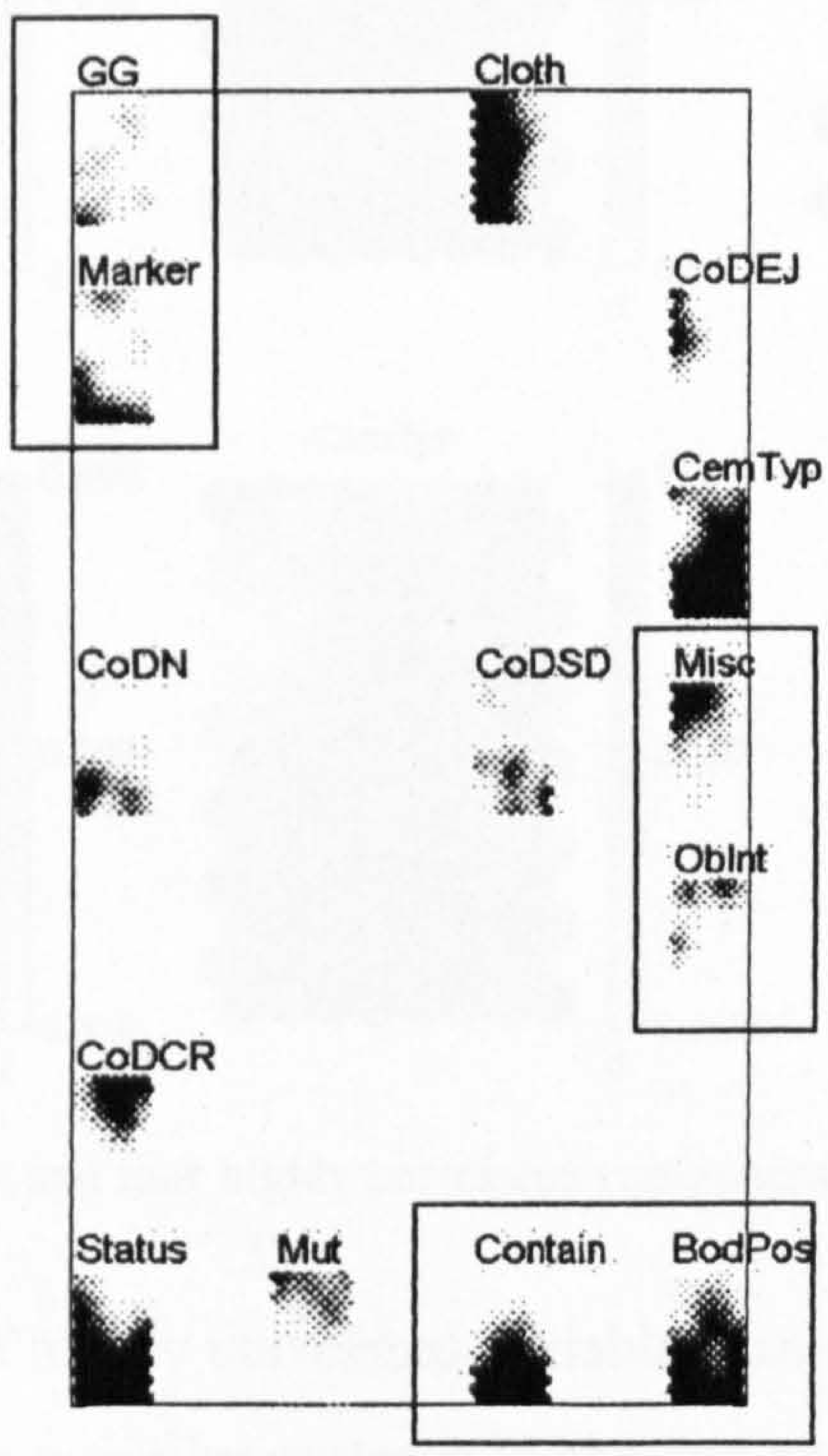


**Figure 6.6** Reorganised corresponding component planes for All Data

The other major use of the component planes visualisation is to identify correlations. The variables in Figure 6.6 form three groups. Normative characteristics are separated into two clusters. One normative variable cluster in the bottom of the map consists of Contain and BodPos with GG and Marker comprising the second group in the top left corner of the map. The variables Misc. and ObInt comprise another variable cluster. The similarity of component planes in each group indicates that the variables are well correlated. The spatial positioning of each variable is discussed below.

In analysing the component plane representation for relationships among variables, patterns in shading emerge. These correlations are clearly discernible in corresponding component planes as similar configurations of sharp dark or light areas. As represented in Figures 6.7 and 6.8, component planes illustrate the connections and correlations between the variables.

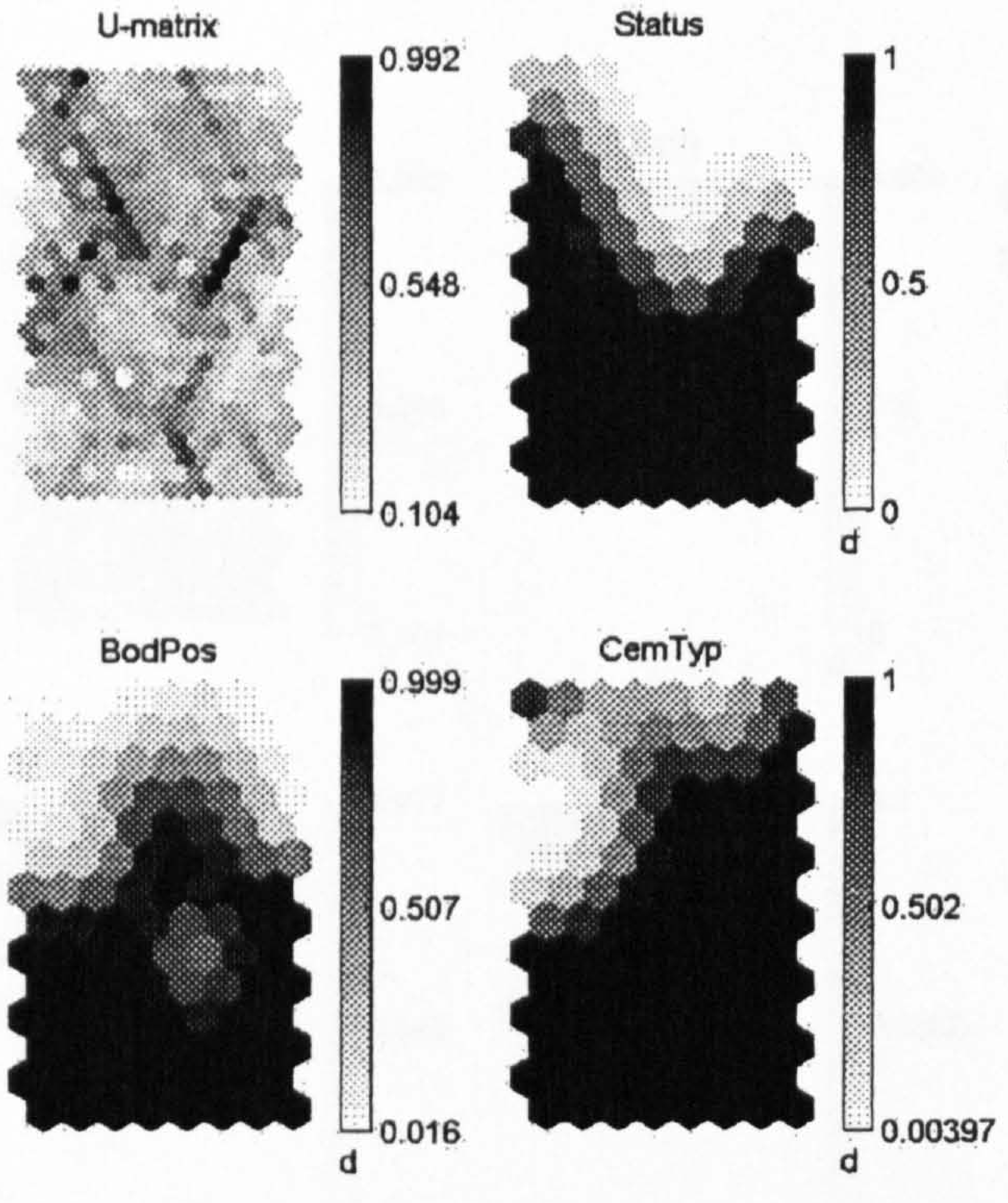


**Figure 6.7** U-matrix and four highly correlated component planes for All Data

Close-ups of two groups of highly correlated variables are shown in Figures 6.7 and 6.8. Four variables that have similar patterns in shading and values that correspond to behaviour in normative cases are shown in Figure 6.7. In addition, the shading patterns and high values for each variable correspond to the location of the normative cases. The expected correlations of normative behaviours (i.e. BodPos, CemTyp, Status, and Container tend to go together) are realised.

The four variables among the conflict cases that have the strongest correlations are illustrated in Figure 6.8. These component planes demonstrate by the patterns in shading, behaviour opposite to those variables in Figure 6.7. While that shading may be located in different portion of the plane, the influence these three variables, CoD-CR, Mut, and Misc., have is very high. Again, the location of the burials within the component planes confirms the role each of these variables has in how the data was clustered. For example, in the Misc. component plane in Figure 6.8 the normative cases are at the bottom of the plane, where the value is zero, while the conflict cases are dispersed in the areas where the value is higher, again exhibiting expected correlations among variables and cases.

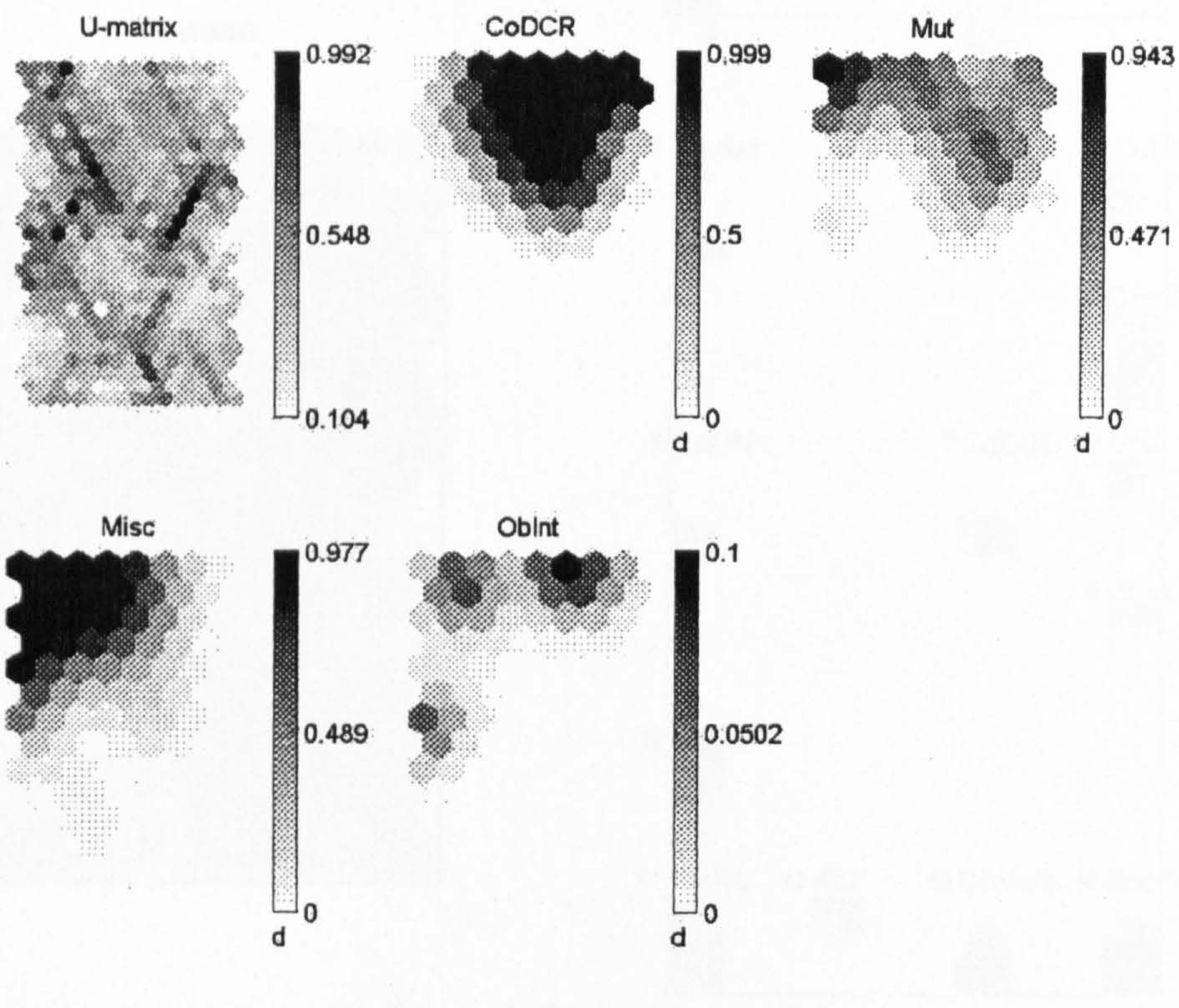


**Figure 6.8** U-matrix and four highly correlated component planes for All data

The next step is to study where each of the component planes (variable) is located on the overall map as proposed by Siponen et al. (2001: 4) and Laine (2003: 21). This is also done by analysing the component planes.

The location of each of the 14 component planes (variables) on the overall u-matrix map corresponds to where on the resulting map the cases that possess that characteristic are placed. Consider the SOM examples in Figure 6.9: the component planes BodPos (body position), Contain (normative container present), and Status (civilian) (numbers 11, 13, and 14, respectively) all occupy the lower part of the u-matrix where the normative cases that have those characteristics are also located on the u-matrix.

This pattern in placement confirms the expected strong correlation between these variables and the normative cases that are located in the bottom portion of the u-matrix (as labelled in Figure 6.1). This pattern in component plane placement suggests that these three variables (ObInt, Misc. and CoD-CR) would not be associated with the more normative variables in the lower part of the u-matrix.

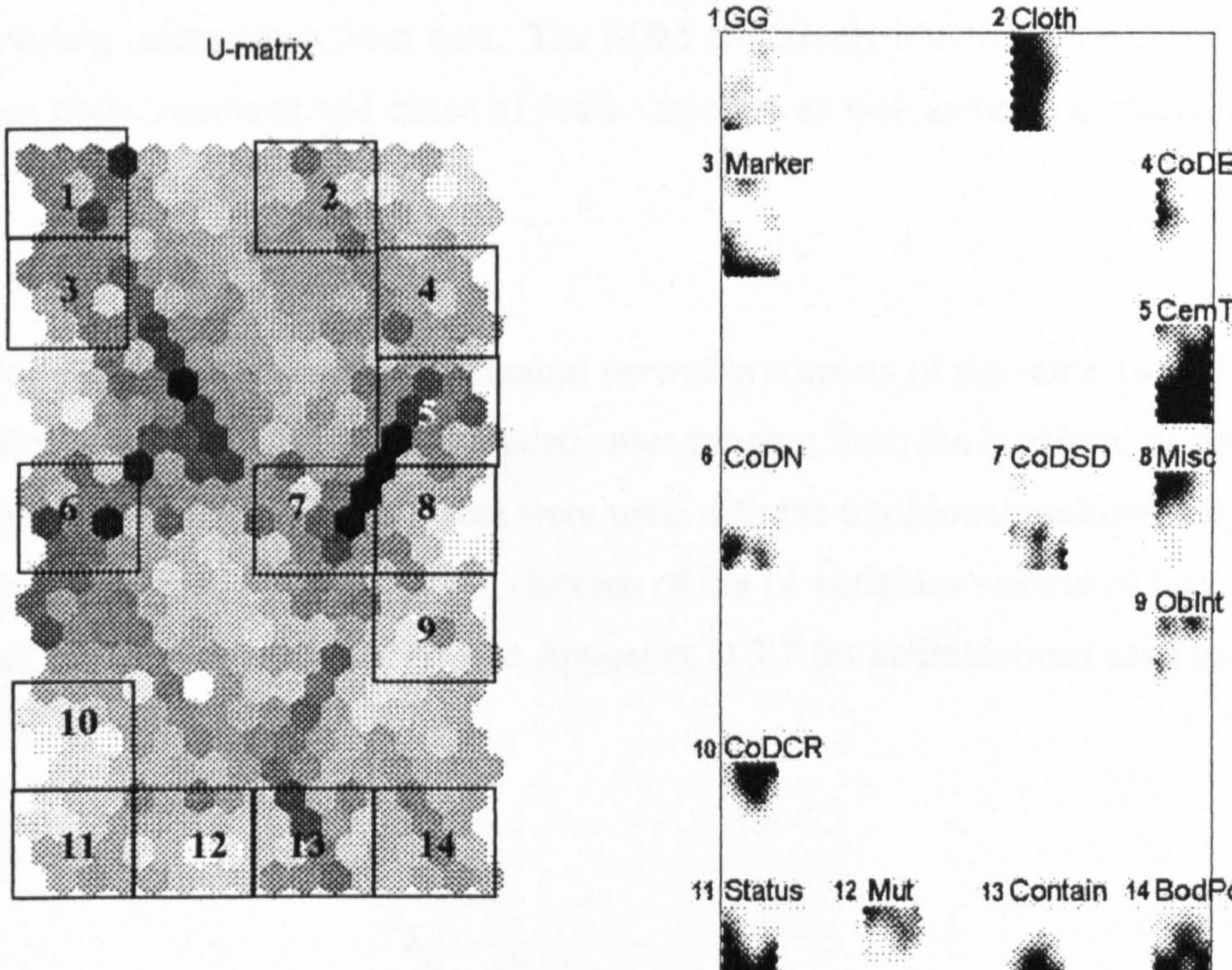


**Figure 6.9** U-matrix and corresponding component planes for All Data

### 6.3.1.a Discussion

The clustering of the maps was based on visual inspection of the u-matrices and component planes shown in Figures 6.1 to 6.9, as well as the interpretation of the distribution of component plane values. As indicated in Figure 6.1, three clusters correspond to normative burials, two clusters represent friendly conflict burials, and a sixth cluster consists of hostile burials with large distances between map units on either side because there is a high degree of dissimilarity between this cluster and the surrounding clusters.

The SOM method using the 14 variables produced good differentiation of normative versus conflict burials, as well as separating friendly conflict from hostile conflict burials. The method also clustered burials on degrees of friendly behaviour. In addition, the u-matrix (Figure 6.1) identified a band of very dissimilar cases, which did not follow a pattern of any of the three burial types that acted as a boundary between the normative and friendly cases.

The different projections used offered efficient ways to visualise data and new ways of extracting information from data. The SOM effectively illustrates the correlations between body treatment and cause of death variables as well as ritual markers.

### 6.3.2 ALL CONFLICT DATA

The Conflict dataset used with the neural networks consists of the same 183 individuals in 89 graves, which included cases ranging from the medieval period (1461) to modern times (1995)[4] that were used with the traditional multivariate techniques discussed in Chapter 5. Thirteen of the 14 variables were used because one had zero variance (CoD-N). See Appendix D.3.7 for abbreviations used to identify variables.

---

[4] Abbreviations used as labels to identify sites

| | | | |
|---|---|---|---|
| Ant | Antietam, Maryland, USA | Custer | Little Big Horn Cemetery, Montana, USA |
| Ox | Ox Hill, Virginia, USA | Snake | Snake Hill, Fort Erie, Ontario, Canada |
| Towton | Towton, Yorkshire, UK | SpnB | Benegiles, Zamora, Spain |
| SpnO | Olmedillo de Roa, Burgos, Spain | SpnV | Vadoncondes, Burgos, Spain |
| SpnVil | Villaviciosa, Asturias, Spain | Bosnia | Bosanski Petrovac, Bosnia-Herzegovina |
| Croat | Pakračka Poljana, Croatia | Korea | Kujan, P'yongan-Pukto Prov., N. Korea (et al.) |

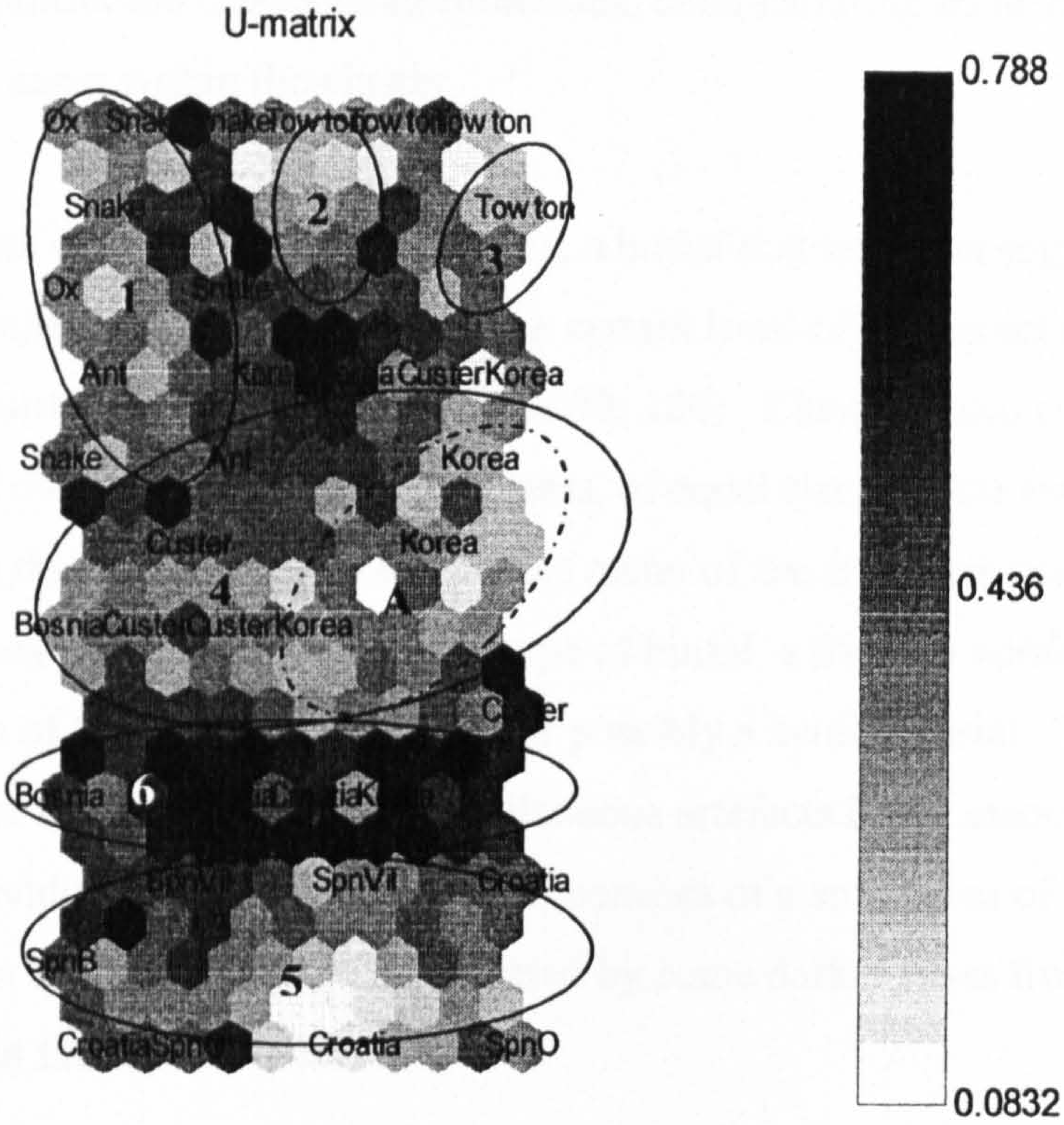


**Figure 6.10** U-matrix for All Conflict data (visually defined clusters circled)

Two types of maps were created to identify the burial types: u- and d-matrix clustering of the burial types (Figures 6.10 and 6.11); and the values of the component (variable) planes (Figures 6.16, 6.17, 6.18, and 6.19). The first of these maps define clusters based on 13 of the 14 variables. Additional maps with extracts of features (Figures 6.12, 6.13, 6.14, and 6.15) are used to visualise some of the more subtle distinctions.

**U-matrix**

The general u-matrix of the SOM of all the conflict data is shown in Figure 6.10. The clustering splits the SOM into two general parts based on status. These two parts are then further differentiated to six smaller clusters. In addition, within the Cluster 4, there is a smaller sub-cluster. The clusters and their descriptions are shown in Table 6.2. See Appendix H for individual case records.

Cluster 1 corresponds to friendly conflict burials with a high number of ritual markers. All of the cases from the Ox Hill site and some cases from the Antietam and Snake Hill sites are included. Furthermore, the remaining cases from Antietam and Snake Hill border the cluster in all directions, demonstrating some degree of similarity to the cases within the cluster.

Cluster 2 includes cases from the Towton site, a burial that has been suggested that it was friendly (Sutherland 2000: 41), there is a certain level of disrespect also present in the Towton burial (Knüsel and Boylston 2000: 186). Cluster 3 also consists of cases from the Towton site. These two clusters, of equal size, got the least number of hits, meaning that these cases do not posses many of the attributes used to define burials here. They also correspond to one type of burial, a friendly conflict burial with a minimum of friendly characteristics or possibly a neutral burial. These cases are divided based on the presence of miscellaneous artefacts being associated with some of the individuals. The top right corner consists of a small area of very light coloured conflict units; this cluster is separated by some darker cases from the other conflict cluster in the top left corner.

Cluster 4, more a roughly defined region separating Clusters 1, 2, and 3, from Cluster 6, is comprised of cases from Bosnia, Custer, Antietam, Snake Hill, and Korea that are moderately similar to each other, with some degree in variation in the shading. In addition, there is an identifiable, slightly distant, sub-cluster (Cluster 4A) comprised of burials from Korea that are more uniformly shaded, representing little distance (high similarity) between cases. The composition of Cluster 4 indicates (with the exception of Cluster 4A) friendly burials with a minimum of effort, or possibly neutral burials. The placement of the sub-cluster within the larger friendly or neutral cluster and in proximity to the hostile Cluster 6, as well as having the characteristics listed in Table 6.2 indicates that Cluster 4A is made up of either neutral or hostile burials. The clusters of the Towton data are separated from the friendly burials by the absence of ritual markers and separate from the hostile burials by the absence of miscellaneous artefacts.

Cluster 5, highlighted at the bottom of the u-matrix, is made up of hostile burials from Croatia, Bosnia, and the four Spanish sites. The cases are quite similar to each other with the dissimilarity increasing in either direction from the centre of the cluster. This cluster, comprised of cases with hostile burial characteristics, is clearly separated from the other conflict clusters.

Separating Cluster 4 from Cluster 5 is Cluster 6. This cluster is a band of not only distant (very dissimilar) from the clusters on either side – as represented by the scattered black ravine, but the cases within the band are rather dissimilar from each other. The cases here do not follow a consistent pattern of characteristics of either friendly or hostile burials, but contain all aspects (e.g. miscellaneous artefacts, container, marker, mutilation, normative and non-normative body positioning, normative and non-normative cemetery). The one characteristic that all the cases share is military status. This combination of variables not only places them bordering both friendly and hostile clusters and indicating distance from neighbouring cases, but creates a band of neutral burials.

**D-matrix**

The d-matrix results (Figure 6.11) again are similar to the u-matrix. It separates the burials into a number of clusters; however, there are fewer and smaller clusters than in the u-matrix. Most cases belong to one of four clusters, with some cases (represented by the small marker size) near the centre separating Cluster 3 from the others. While this projection is clearer than the u-matrix in identifying broad patterns in conflict burials, the slight differences in some of the burials is not as apparent in this map; especially as Cluster 3 clearly has links to Cluster 4 in the previous diagram and Cluster 6 is not present here.

| **Cluster** | **Burial Type** | **Variable(s)** |
|---|---|---|
| 1 | Friendly | Military Status, CoD-CR, Body Position, Misc.Artefacts, Clothing, Container |
| 2 | Friendly | Military Status, CoD-CR, Mutilation |
| 3 | Friendly | Military Status, CoD-CR, Clothing, Misc.Artefacts |
| 4 | Neutral | Military Status, CoD-CR, Clothing, Misc.Artefacts, Clothing, Container, Marker, Mutilation |
| 4A | Neutral | Military Status, CoD-CR, Misc.Artefacts, |
| 5 | Hostile | Civilian Status, CoD-EJ, Clothing, Misc.Artefacts |
| 6 | Hostile | Military Status |

**Table 6.2** Cluster assignment for All Conflict data.
The cluster refers to areas marked on Figure 6.10

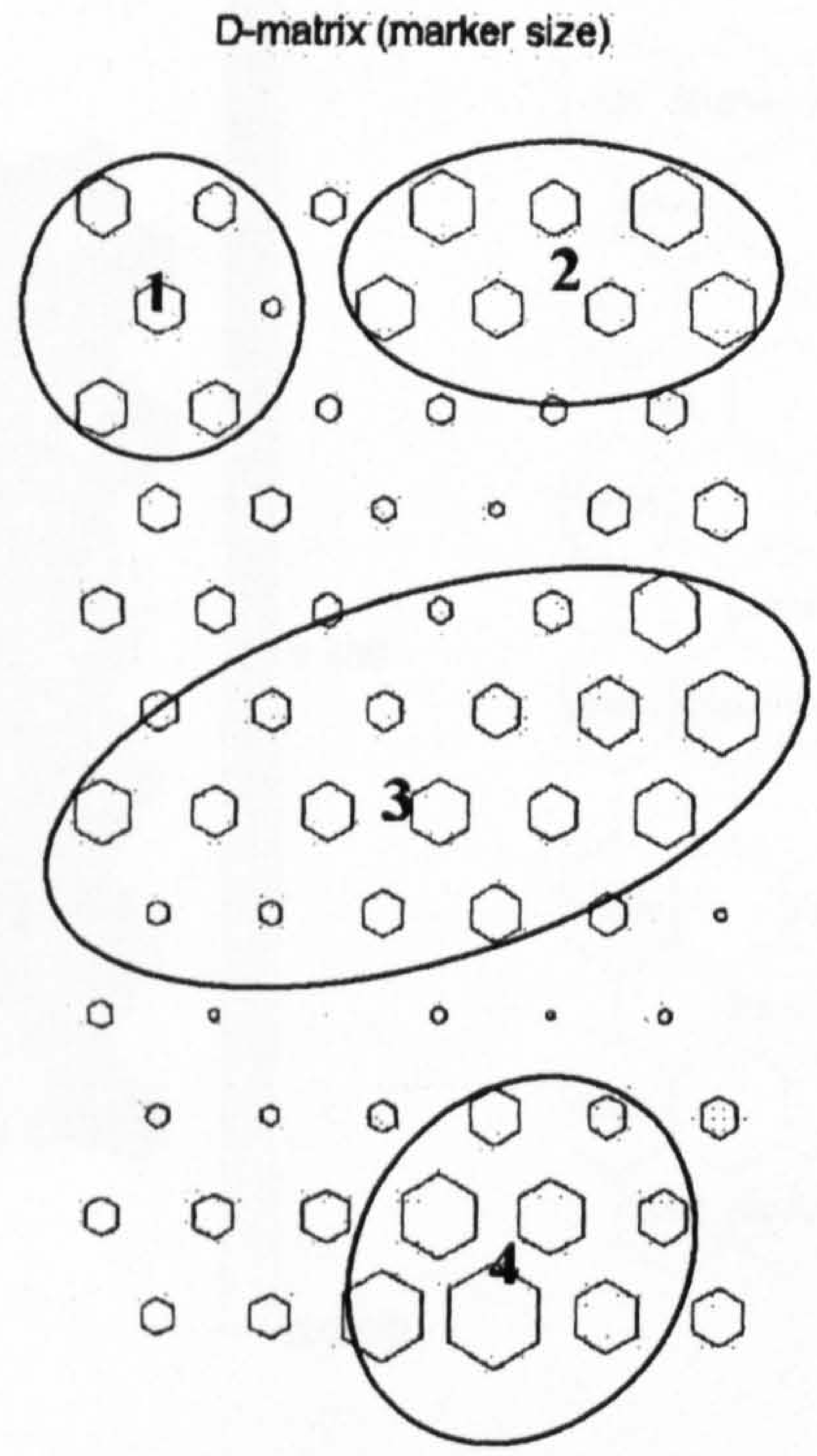


**Figure 6.11** Distance matrix or d-matrix (marker size) for All Conflict data (visually defined clusters circled)

**U-matrix and BMU**

The u-matrix and BMU map indicated the same six clusters as in Figure 6.10. As well as identifying the BMU's for the map, the colour coding separates the different sites. Several maps with the combined features of the u-matrix, BMU, and colour coding were created to highlight different patterns.

The most obvious pattern in the first of the u-matrices (Figure 6.12) is the separation of red and green units based on status. This feature pinpoints the case that represents the centre of each cluster, thereby indicating the ideal representation of the cluster. For example, in Figure 6.12, case 82, a burial from the Towton site has a higher value (by virtue of the size of the coloured hexagon) than its immediate friendly red neighbours. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space. For the Croat site, case 115 represents the case with the highest value of component planes for the hostile burials.

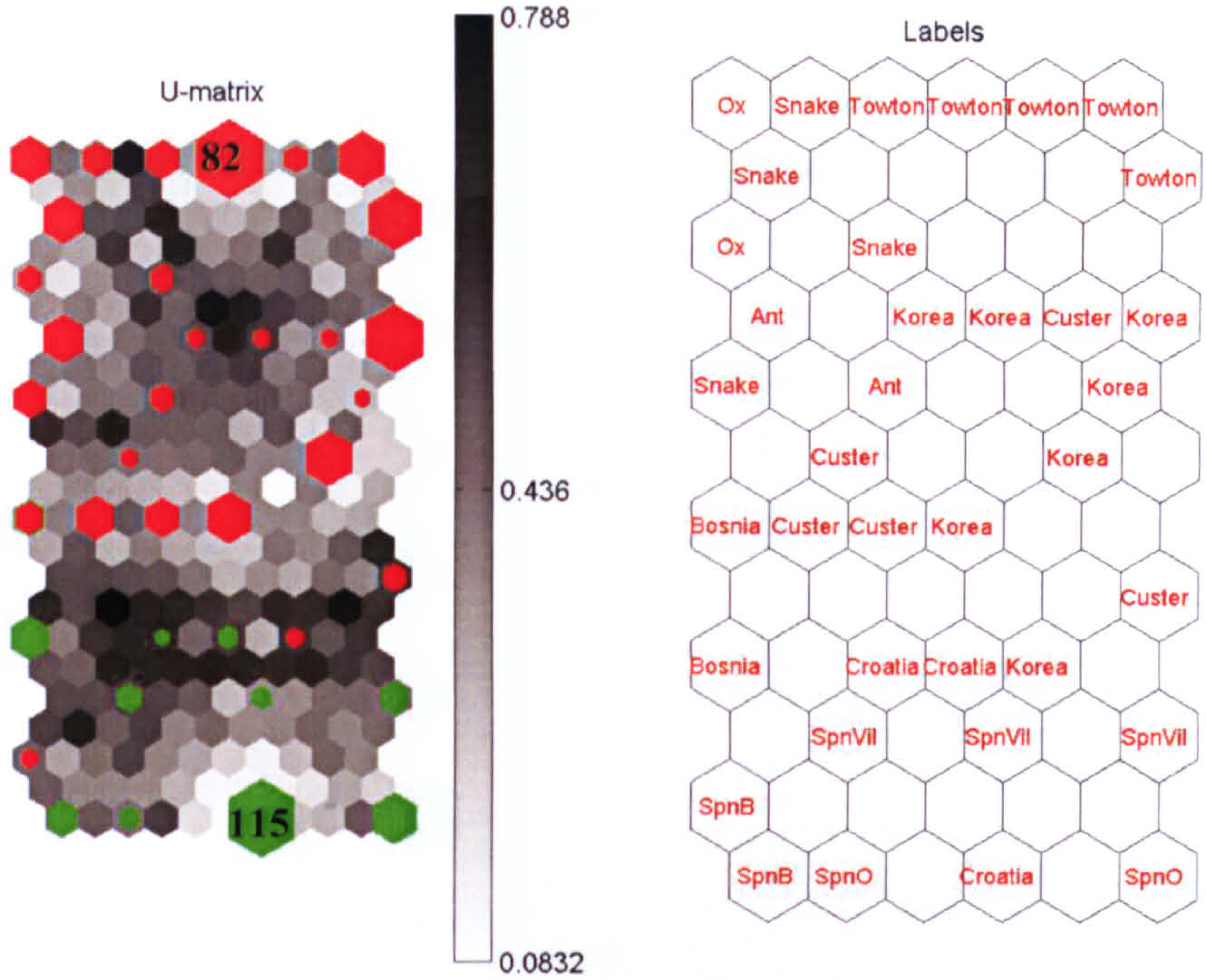


**Figure 6.12** U-matrix and corresponding labels and colour coded BMU's for All Conflict data (Green: Spain and the Balkans; and Red: Korea, Towton, and 19th Cent. North America)

The burials from Korea, Spain, and the Balkans are highlighted in Figure 6.13 in order to focus on non-friendly burials. The cases labelled in Figure 6.13 illustrate that the clustering broadly separated the cases based on status with the civilians located at the bottom portion of the map. There are some exceptions, such as case 96 from Korea (circled in white). This burial has the CoD-SD, which after analysing the location of this variable on the component plane (Figure 6.20) accounts for this case being separated from the other Korea burials. Another exception is case 103 from Bosnia (circled in black). This case has a combat related cause of death (CoD-CR) similar to its neighbouring units, yet by virtue of the size of the coloured hexagon has a lower value than those immediate neighbours that also have CoD-CR.

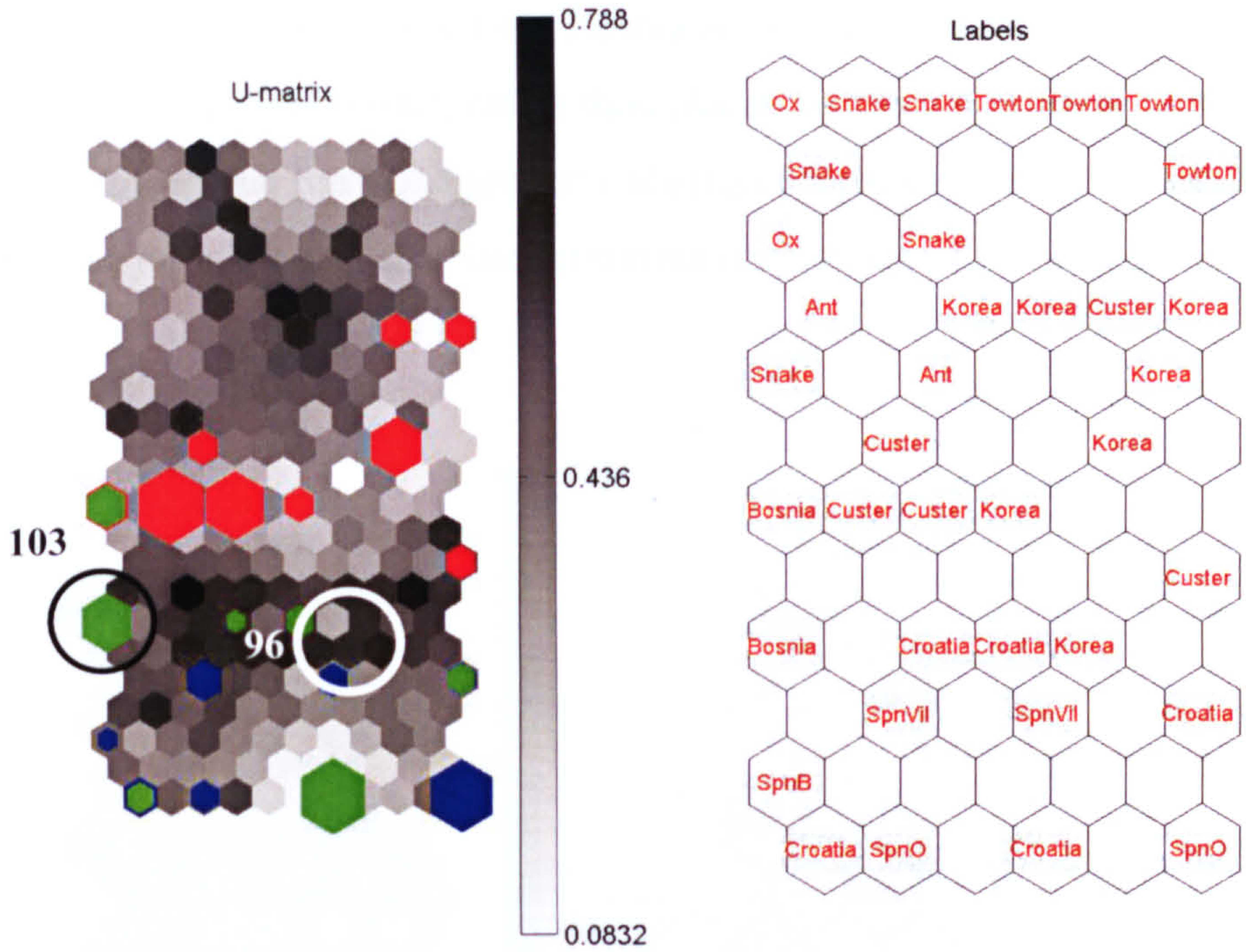


**Figure 6.13** U-matrix and corresponding labels and colour coded BMU's for All Conflict data (Blue: Spain; Green: the Balkans; and Red: Korea)

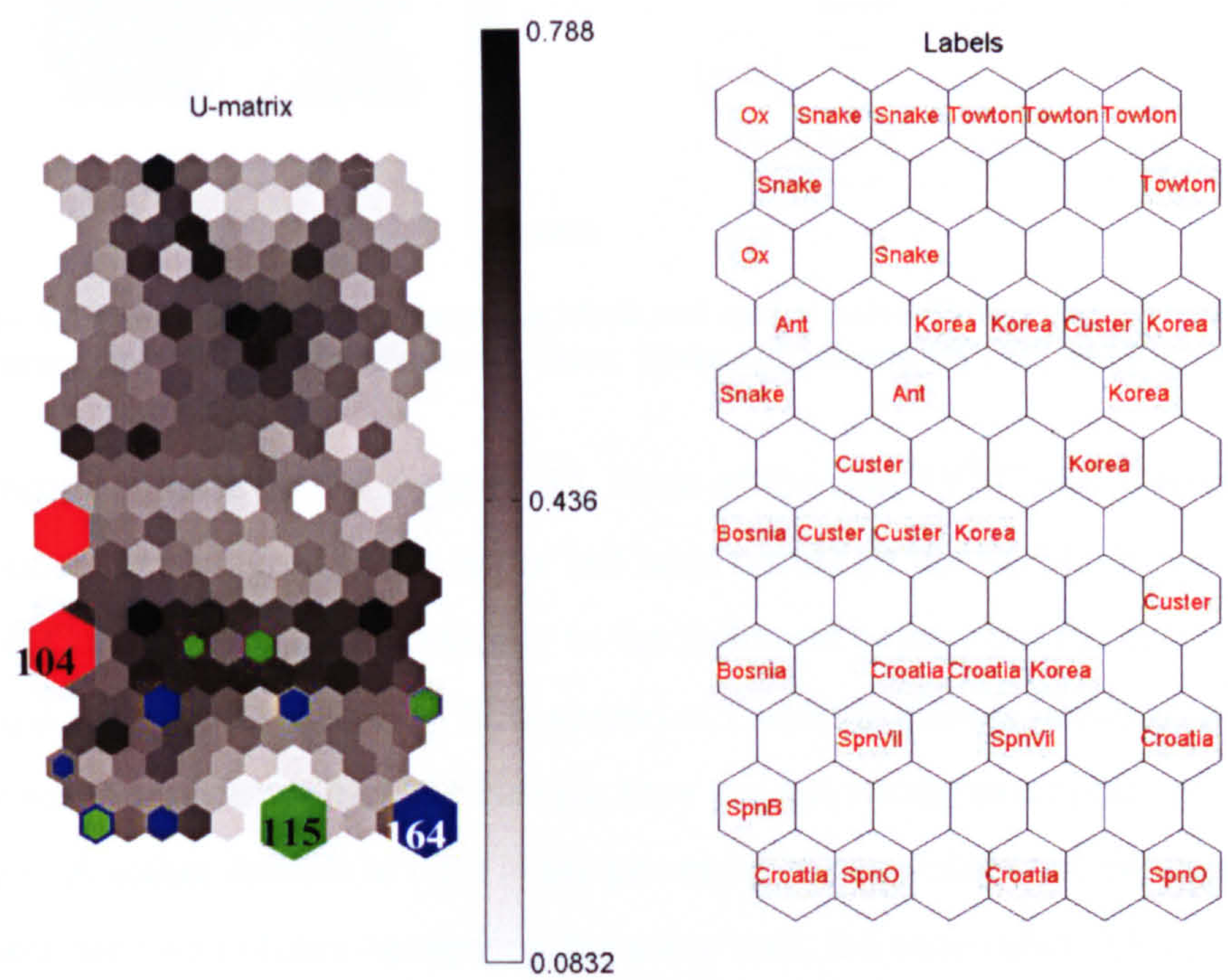


**Figure 6.14** U-matrix and corresponding labels and colour coded BMU's for All Conflict Data – focusing on non-friendly burials (Blue: Spain; Green: Croatia; and Red: Bosnia)

The sites in which extra-judicial killing was the predominant cause of death were singled out in Figure 6.14. This separation is not only based on status, but also cause of death (CoD-CR for the Bosnia burials and CoD-EJ for Croatia and Spain burials). Nevertheless, the cases from Bosnia are still located near the bottom of the map closer to the hostile burials, rather than placed with other military status cases. This demonstrates that the SOM properly identified a pattern within the entire context of the burials rather than concentrating on just one or two dominant variables.

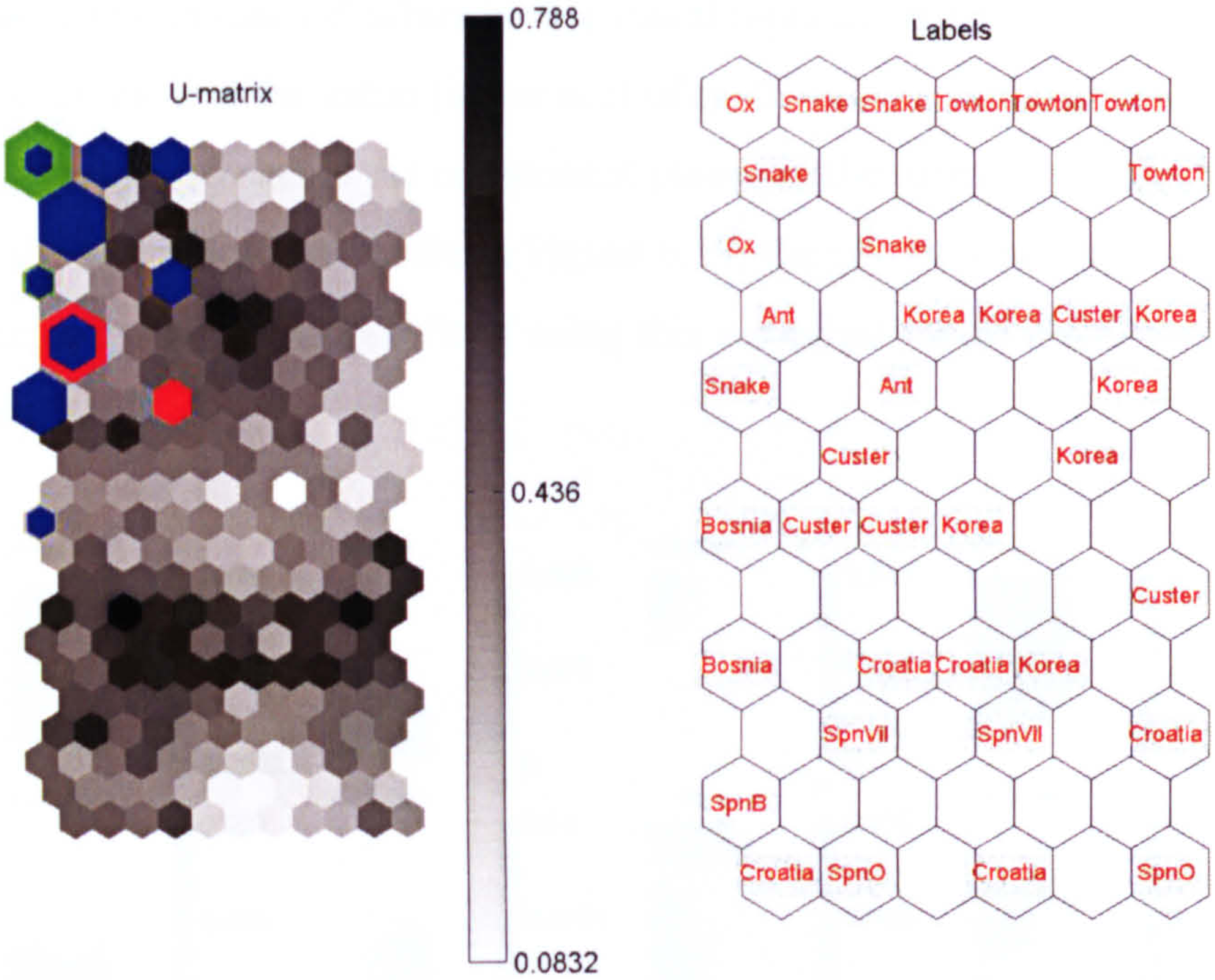


**Figure 6.15** U-matrix and corresponding labels and colour coded BMU's for All Conflict Data - focusing on 19th Cent. North America (Blue: Snake Hill; Green: Ox Hill; and Red: Antietam)

It is interesting to note that in Figure 6.15, three of the four 19th Century North America sites are clustered in the upper left hand corner of the SOM. However, the fourth site, Custer, is in close proximity to the right and below, but the cases are interspersed with the Korea data. This spread of Custer burials is because, while they have some aspects of friendly burials, they are not strong exemplars of that burial type. Another feature to note is the presence of two colours in the same unit. Where there are two colours occupying the same unit, the outermost colour represents the higher number of hits in the two burial types present. For example, the Snake Hill burials are represented by the blue hexagons, and on two occasions, the blue hexagon has an outer ring of a different colour, one Ox Hill (green), and one Antietam (red) burials that represent the BMU for the unit, not just the site, e.g. Snake Hill. This dual occupation means that in the upper left-hand corner, the Ox Hill case is the BMU for the cluster because it has more of the characteristics of that cluster; however, the Snake Hill case that also shares the unit, has many of those shared characterises, but not as many as the Ox Hill burial.

**Component Planes**

Component plane reorganisation was used together with traditional correlation analysis because this method offers both a visual representation of correlations between variables, and the value (influence) of each variable in the overall map structure. Figure 6.16 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.17, the component planes are reorganised, illustrating the benefit of using this visualisation for identifying correlations.

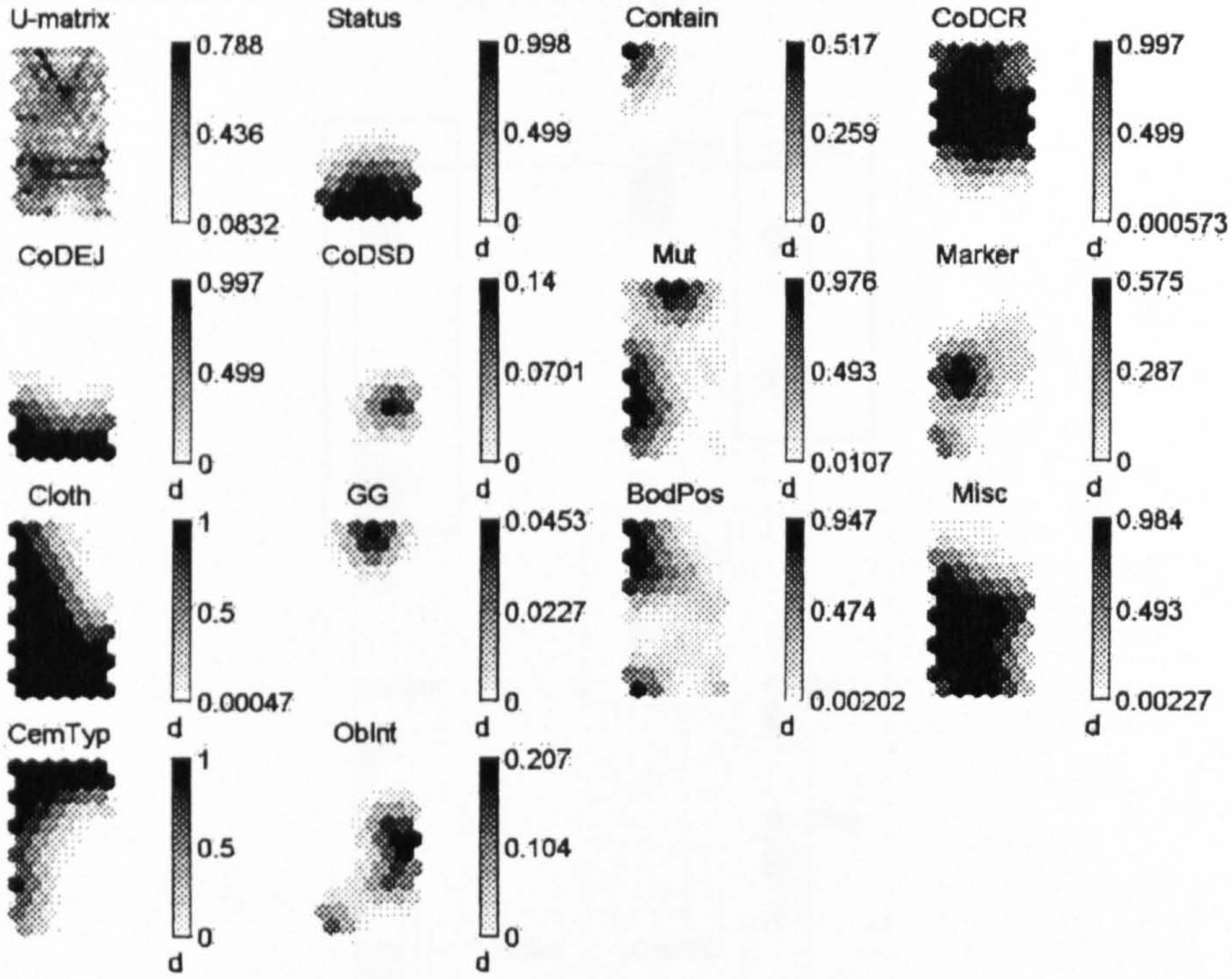


**Figure 6.16** U-matrix and component planes of all variables for All Conflict data

In Figure 6.16 the shade of the variable CoD-SD (cause of death-sickness/disease) is very light with a small spread, indicating a very low value - a maximum of 0.14 on the value bar. Its position in the bottom right hand corner of the plane indicates its correspondence with other variables sharing similar values. Conversely, the variable CoD-CR is very dark with over 65% of the plane having a value of 1. In addition, the location of the higher value shading of the two causes of death are in opposition to one another, suggesting that these two variables would not be present in the same clusters.

The component planes and variable correlations for All Conflict data are represented in Figures 6.16 and 6.17. The shading (hence the burial cases) for cause of death-extra judicial (CoD-EJ) is concentrated in one area near the bottom of the plane. Similar distribution is noticeable in the variable representing the status of an individual (Status). This type of clustering can also be noted on the component plane for miscellaneous artefacts (Misc.). Thus, it is suggested that those individuals of civilian status tend to have extra-judicial cause of death (visually, roughly 25%) and miscellaneous artefacts present. Some variables are highly correlated which is recognisable through visual inspection. One such pair is normative body position (BodPos) and normative cemetery type (CemTyp).

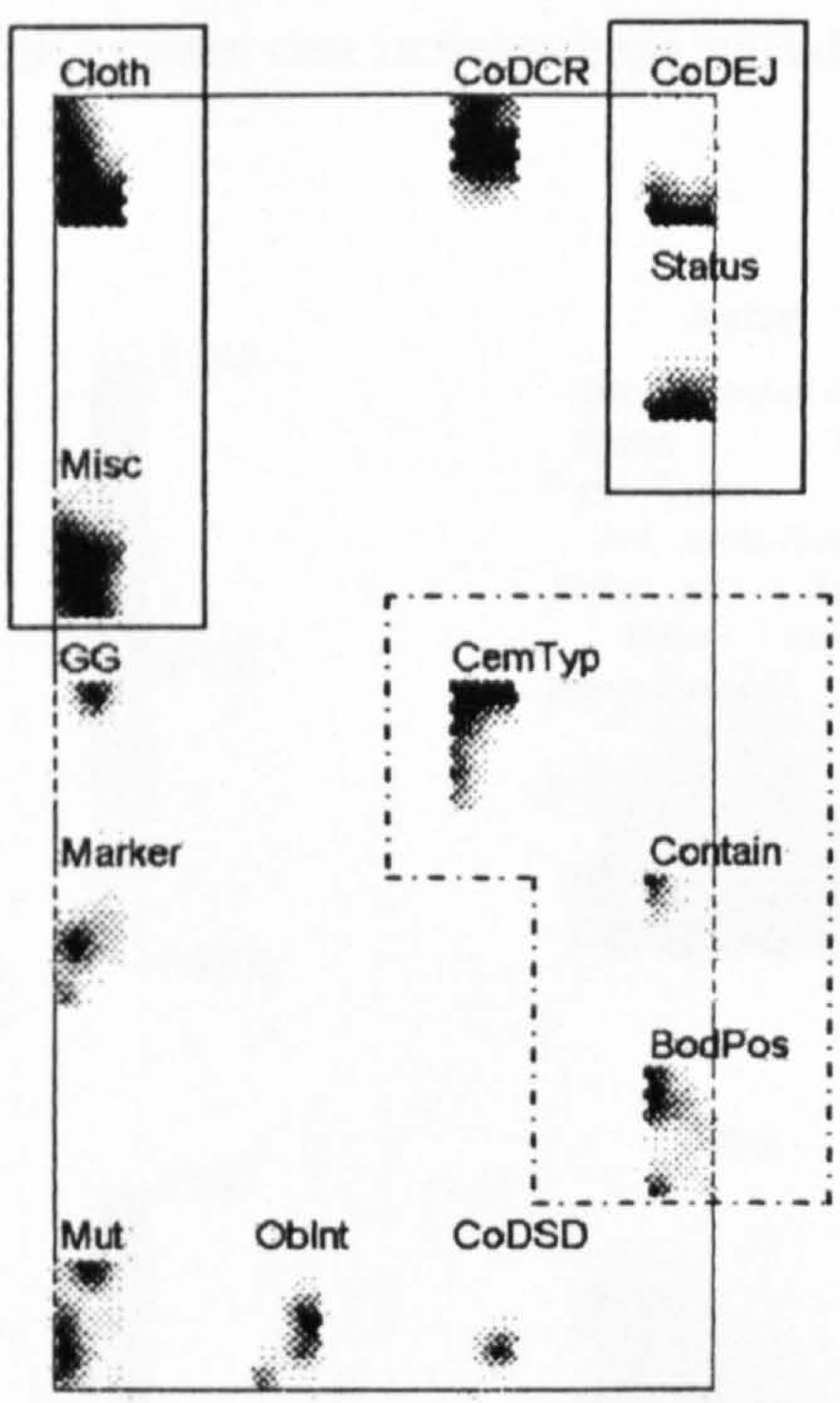


**Figure 6.17** Reorganised corresponding component planes for All Conflict data

Close-ups of two groups of highly correlated variables for hostile versus friendly burials are shown in Figures 6.18 and 6.19 respectively. Three variables that have similar patterns in shading and values that correspond to behaviour in hostile burials are shown in Figure 6.18. It can be noted that the cases from the Bosnian, Croatian, and Spanish sites, which have CoD-EJ as the dominant cause of death also have a high rate of miscellaneous artefacts (Misc.) and Status (civilian).

Four significant components present in friendly conflict burials are shown in Figure 6.19. While the rates of occurrence are not high for Contain and, especially, grave goods (GG), (0.517 and 0.0453 respectively), these two variables are not only correlated to each other, but also to CemTyp and BodPos. Note that the cases from the 19$^{th}$ Century North America sites have high rates of normative cemetery and body position and the presence of a container. In addition, the shading patterns and high values for each variable correspond to the location of these cases (as illustrated in the BodPos component plane labels). This confirms that the friendly burials that posses a container will be placed in a normative body position and located in a normative cemetery. While the correlations presented in Figures 6.18 and 6.19 are what are expected to occur in hostile and friendly burials, respectively, these representations show how the system can isolate these variables and combine them in a realistic way.

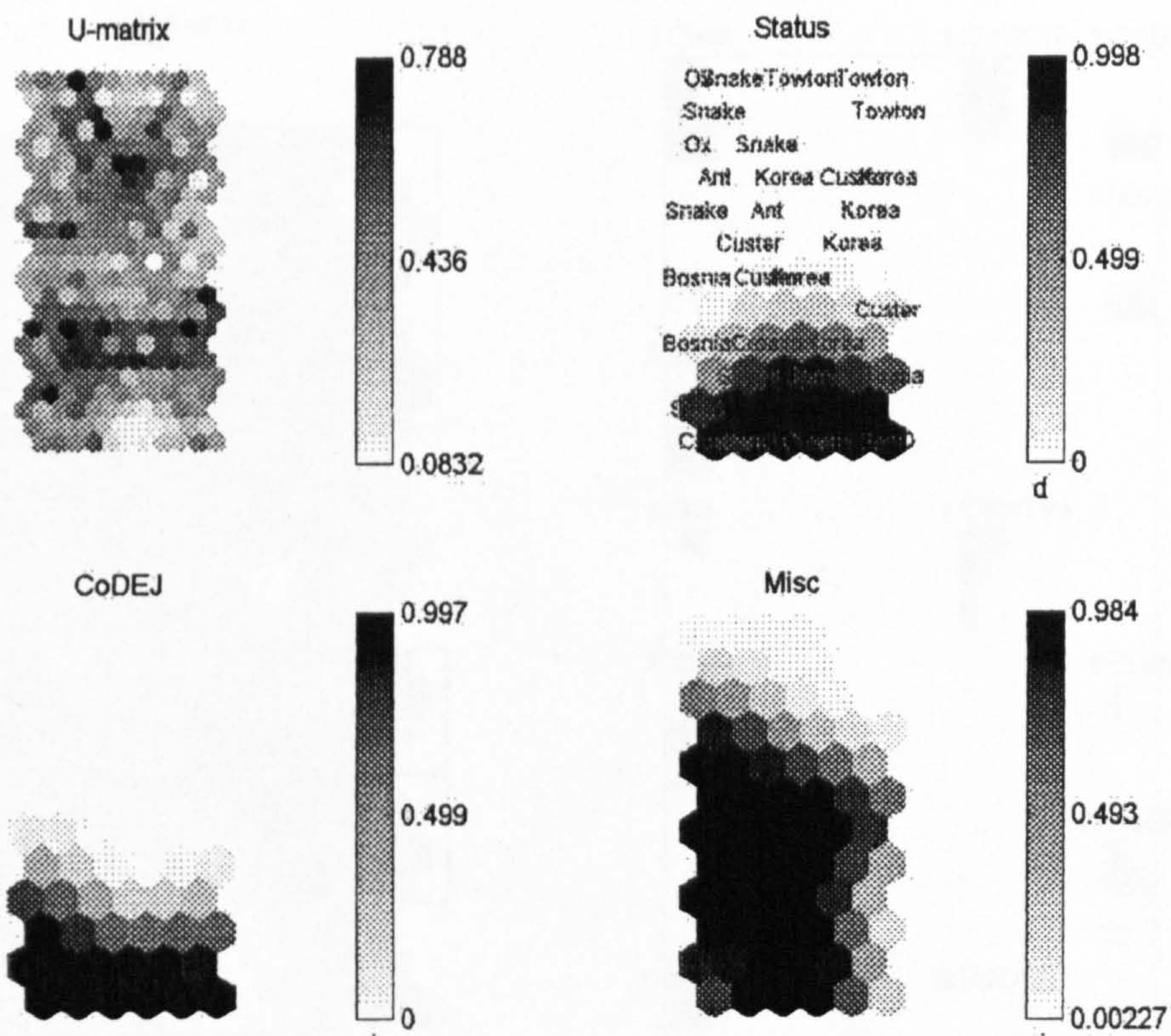


**Figure 6.18** U-matrix and three highly correlated component planes for All Conflict data

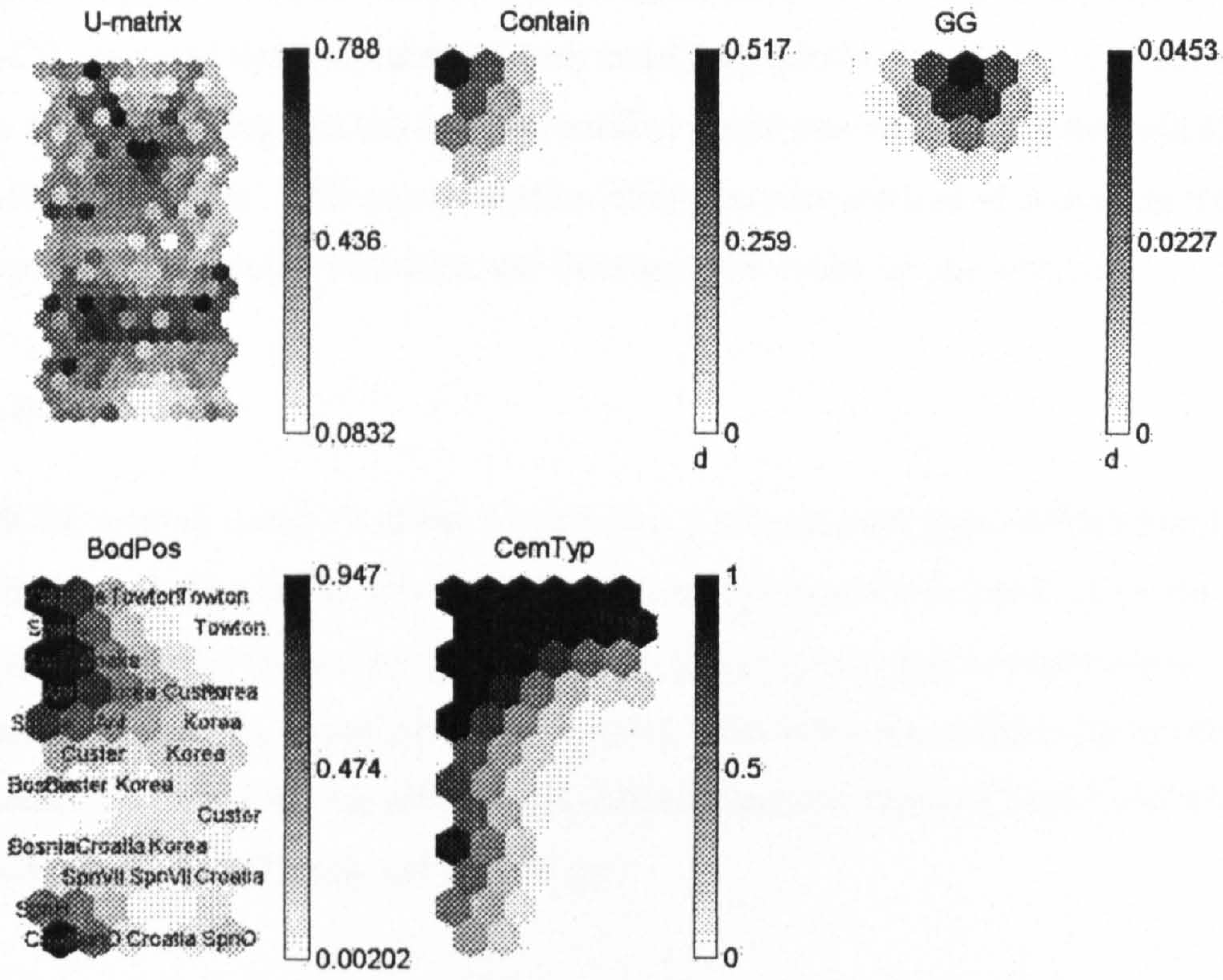

**Figure 6.19** U-matrix and four highly correlated component planes for All Conflict data

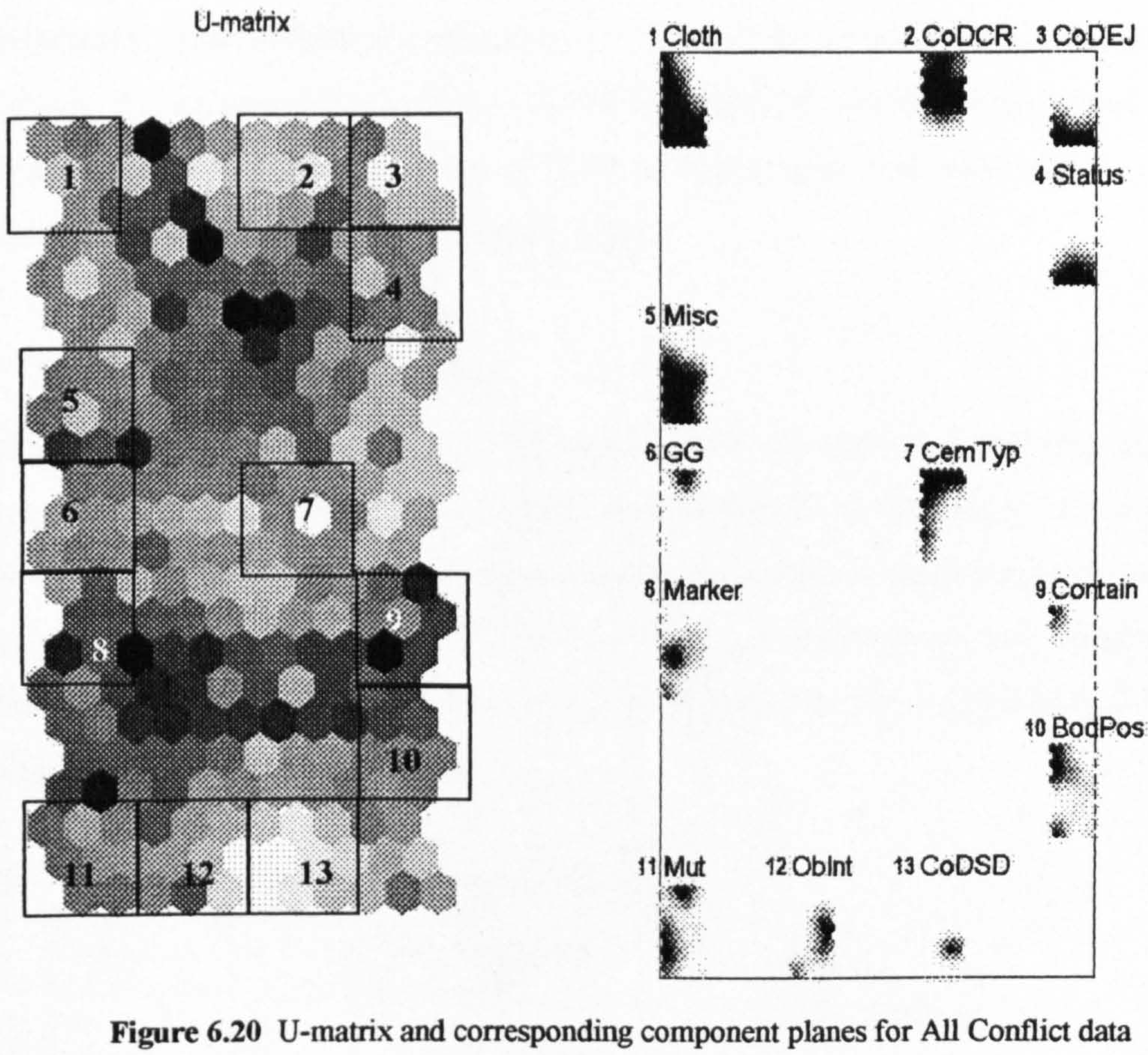

**Figure 6.20** U-matrix and corresponding component planes for All Conflict data

Component plane location is illustrated in Figure 6.20. The component planes for CoD-CR (cause of death-combat related) and Cloth (clothing) planes are at the top of the map, indicating that the friendly conflict burial cases they represent would have these attributes. This representation offers another method of analysing the relationship between the variables and the cases that make up the u-matrix.

#### 6.3.2.a Discussion

The SOM method using 13 of the 14 variables produced very good differentiation of the different conflict burial types, based on clusters primarily determined by the presence of ritual markers (i.e. grave markers, grave goods, and miscellaneous artefacts not normally associated with burials). The SOM also effectively illustrated correlations between the variables in the different general types of burial and which variables strongly influence each burial type.

The SOM successfully separated friendly and hostile burials, as well as differentiating cases that can be labelled as neutral based on the burial characteristics. The method also clustered burials on degrees of friendly behaviour. In addition, the u-matrix (Figure 6.10) identified a band of very dissimilar cases, which did not follow a pattern of any of the three burial types that acted as a boundary between the hostile and friendly cases.

### 6.3.3 Spain Data

As with the Spanish data discussed in Chapter 5, the Spain data used with the SOM consists of the same 68 cases: 34 from four conflict sites from the Spanish Civil War (1936-1939) and 34 cases representing normative burials from Northern Spain and the Basque region from the early 20th century[5] (for more information, see Chapter 3). Ten of the 14 variables were used because four had zero variance (Status, CoD-CR, Clothing, and Obscuration).

[5] Abbreviations used as labels to identify sites and burial type
SpnB Benegiles, Zamora, Spain (Conflict)
SpnO Olmedillo de Roa, Burgos, Spain (Conflict)
SpnV Vadoncondes, Burgos, Spain (Conflict)
SpnVil Villaviciosa, Asturias, Spain (Conflict)
SpnNrm Villanueva, Castille y Leon, Spain (Normative)

The maps created from the Spanish data by the SOM to identify burial types are of two types: u- and d-matrix clustering of the burial types (Figures 6.21, 6.22, and 6.23); and the values of the component (variable) planes (Figures 6.24, 6.25, 6.26, and 6.27). The simplest of these maps define clusters based on the 10 variables. Several more complex maps add additional features, providing more subtlety to the distinctions.

**U-matrix**

The u-matrix (Figure 6.21) roughly separates the normative burials at the bottom of the map from the conflict burials at the top of the map, with a broadly scattered cluster in the centre. The normative cluster (Cluster 4) is uniformly shaded, representing little distance (high similarity) between cases. Conversely, the two

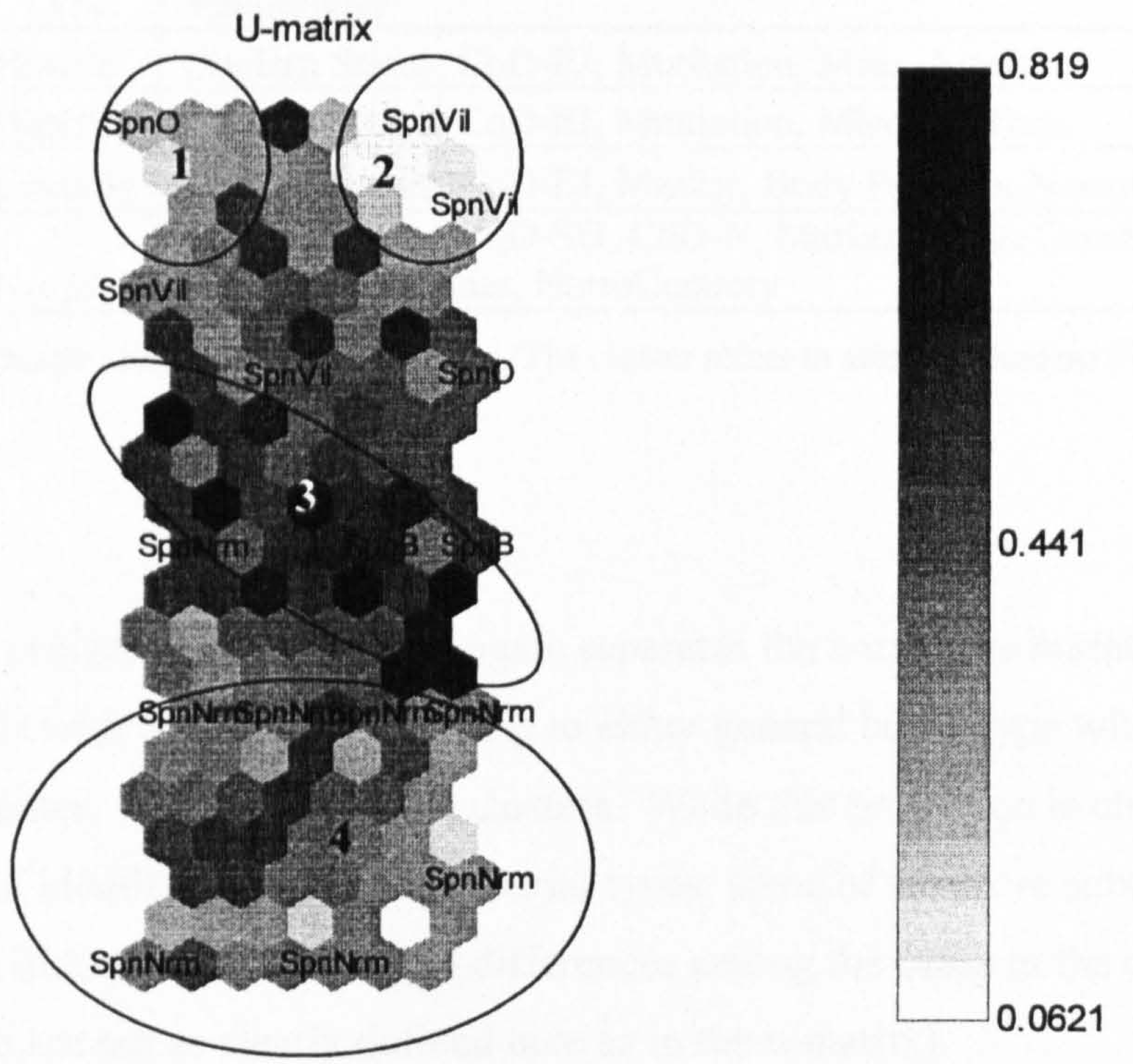


**Figure 6.21** U-matrix for Spain data (visually defined clusters circled)

conflict clusters at the top have varied distances in each cluster represented by the high level of variation in the shades of grey. The top right corner consists of a small area of very light coloured conflict units; this cluster is separated by some darker cases from the other conflict cluster on the top left corner. Significantly, each conflict cluster on the top of the map is comprised of cases from different sites within the Spain dataset (Olmedillo (Cluster 1) and Villaviciosa (Cluster 2)).

The cluster in the centre (Cluster 3) is not only distant (very dissimilar) from the clusters on either side, as well as the cases within the cluster are rather dissimilar from each other. This cluster is made up of normative cases and the three cases from the Benegiles site (see Appendix H for individual case records). The cases from Benegiles site contain some aspects found in normative burials (i.e. presence of a Marker and Grave goods, and a location within a cemetery), which therefore places them bordering both normative and conflict clusters and indicating distance from neighbouring cases (see Table 6.3).

| Cluster | Burial Type | Variable(s) |
|---|---|---|
| 1 | Hostile | Civilian Status, CoD-EJ, Mutilation, Misc. Artefacts |
| 2 | Hostile | Civilian Status, CoD-EJ, Mutilation, Misc.Artefacts |
| 3 | Friendly | Civilian Status, CoD-EJ, Marker, Body Position, NormCemtery |
| 4 | Norm | Civilian Status, CoD-SD, CoD-N, Marker, Grave Goods, Body Position, Container, NormCemtery |

**Table 6.3** Cluster assignment for Spain data. The cluster refers to areas marked on Figure 6.21

### D-matrix

The d-matrix projection (Figure 6.22) again separates the normative burials from the conflict burials with most cases belonging to either general burial type with some cases in the centre, separating the two clusters. While this projection is clearer than the u-matrix in identifying two general burial types, some of the more subtle variations are lost, such as the marked differences among the cases in the centre cluster (which are not as clearly defined here as in the u-matrix).

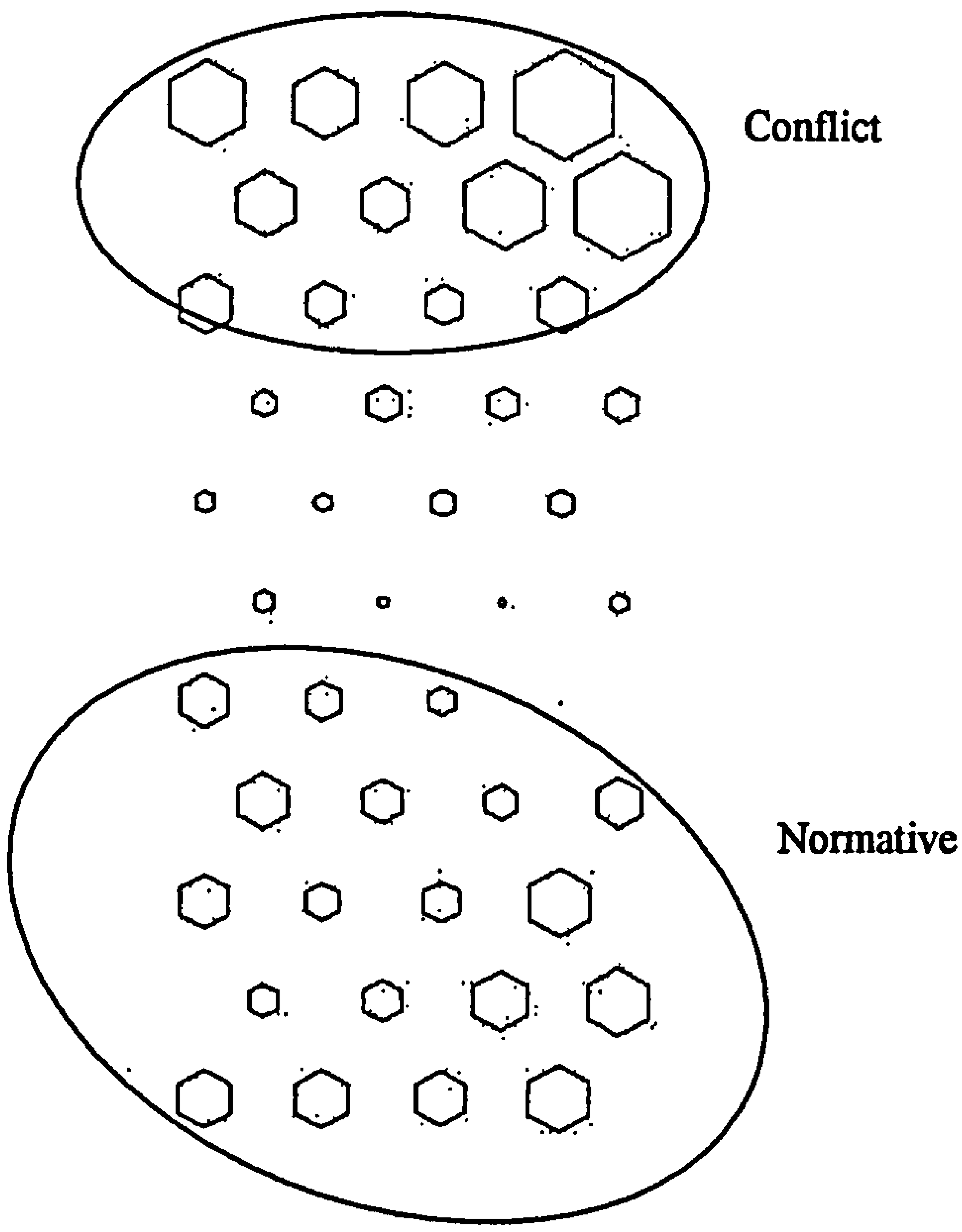


**Figure 6.22** Distance matrix or d-matrix (marker size) for Spain data (visually defined clusters circled)

## U-matrix and BMU

The combined u-matrix and BMU results illustrate the separation of the burials into the same three types as above, e.g. normative cluster, conflict cluster, and a central (indeterminate) cluster. In this map (Figure 6.23), the size of the coloured hexagon is proportional to the value of the data in the corresponding unit. Where there are two colours occupying the same unit, the outermost colour represents the higher number of hits in the two burial types present. There are a number of empty units. There are also a number of concentrations indicating that some burials are very similar to each other. By identifying the BMU for each cluster, this feature pinpoints the case that represents the centre of each cluster. For example, in Figure 6.23, case 1, a burial from the Benegiles site (identified by the black circle), by virtue of the size of the coloured hexagon, has a higher value than its immediate red neighbour. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space. Case 38 represents the unit with the highest value in the normative cluster. In addition to identifying the BMU's for the map, the colour coding separates the different sites. The normative cases are blue, while the conflict cases are green and red (Villaviciosa and Vadacondes, Olmedillo and Benegiles sites, respectively).

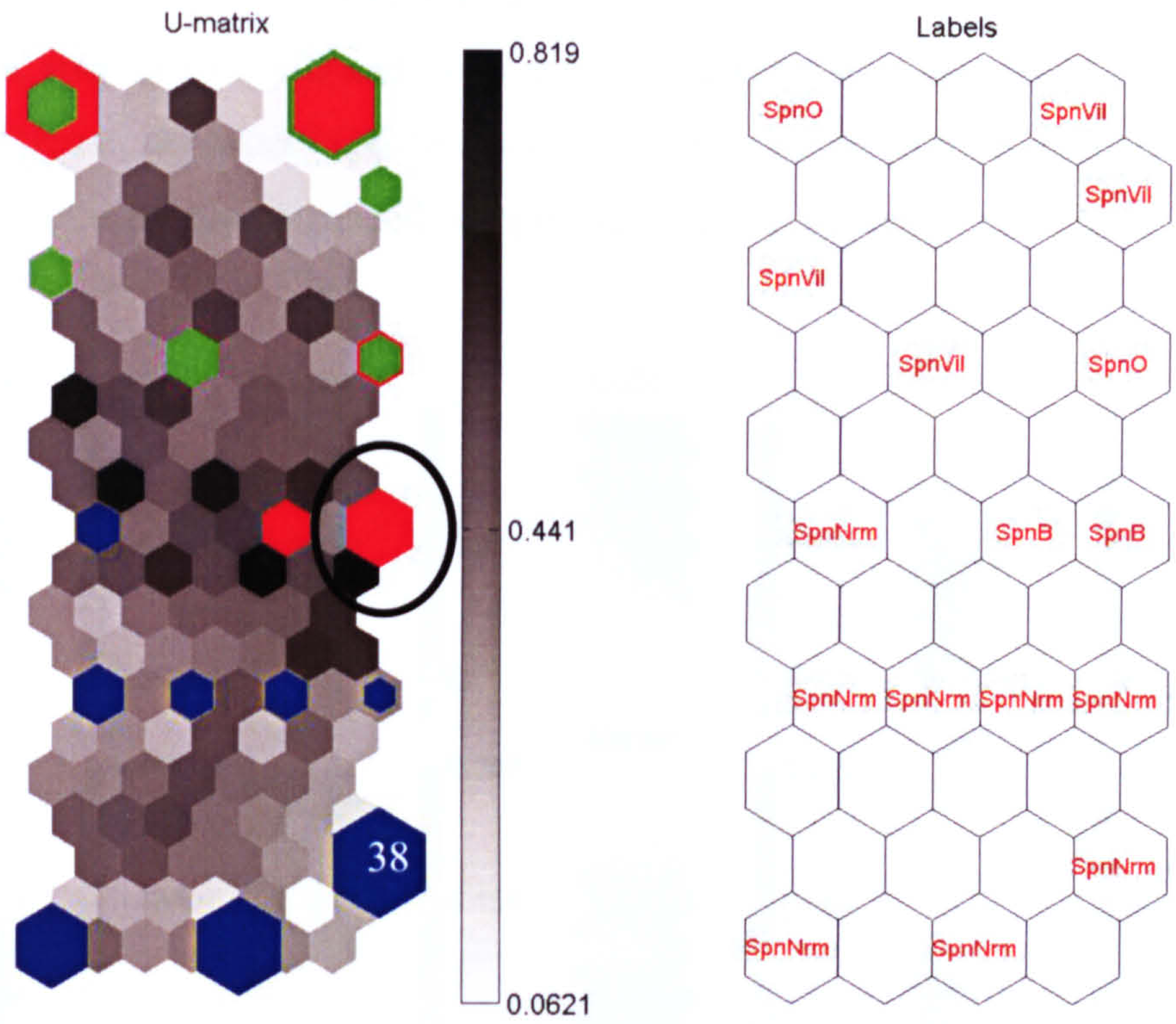


**Figure 6.23** U-matrix and corresponding labels and colour coded BMU's for Spain data (Blue: Normative; Green: Villaviciosa and Vadacondes; and Red: Benegiles and Olmedillo)

### Component Planes

Figure 6.24 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.25, the component planes are reorganised. See Appendix D.3.7 for abbreviations used to identify variables.

In Figure 6.24 the shade of the variable GG (Grave Goods) is very light, indicating a very low value - a maximum of 0.139 on the value bar. Its position in the bottom left hand corner of the plane indicates its correspondence with other variables sharing similar positions. Conversely, the variable BodPos is very dark with over 60% of the plane having a value of 1 (note that the value bar on the u-matrix indicates distance, whereas the value bar on the component planes indicates the spread). Considered together, these representations indicate a high number of individuals in normative body positions and a low number of grave goods in this particular dataset. The placement of shading for Contain and CoD-EJ are at opposite ends of their respective planes, indicting those cases with Contain or CoD-EJ would not have the other. Other similar patterns in shading are apparent in Figure 6.24, such as CoD-SD and Misc. are not characteristics that are likely to be shared in a burial, nor would GG be associated with a burial with Misc. Further discussion on the highly correlated component planes is below.

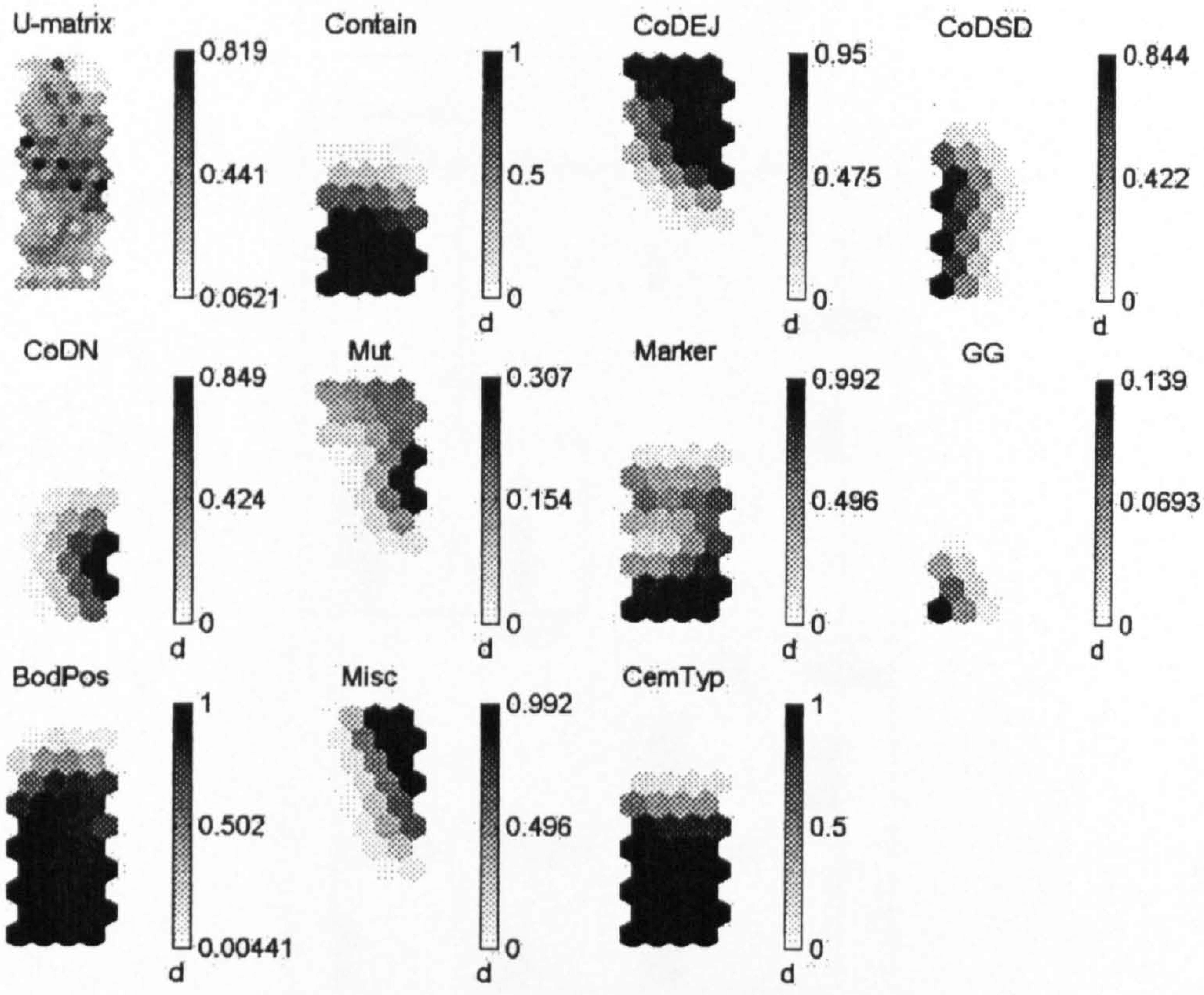


**Figure 6.24** U-matrix and component planes of all variables for Spain data

The second use of the component planes visualisation is identifying correlations. Correlations are indicated by a similarity in position of different variables within the matrix. The variables in Figure 6.25, for example, form two distinct groups. Contain, CoD-SD, CoD-N, Marker, GG, BodPos, and CemTyp comprise one group, while the variables CoD-EJ, Mut and Misc. comprise another. The similarity of component planes in each group indicates that the variables are well correlated. What the spatial positioning of each variable means is discussed below.

The component planes indicate strong correlations for Container, BodPos, CoD-SD, and CemTyp, with a weaker correlation to Marker (Figure 6.25). Conversely, CoD-EJ, Mut, and Misc. Artefacts occupy the opposite location in their respective component planes to that of normative container, suggesting that these variables would not be associated with normative container. This pattern of opposing value placement extends to the other variables as well. It should be noted that the three different causes of death represented here possess different patterns in their respective component plane; such as CoD-SD occupies the bottom left-hand corner of its plane, while CoD-N is in the bottom right-hand corner.

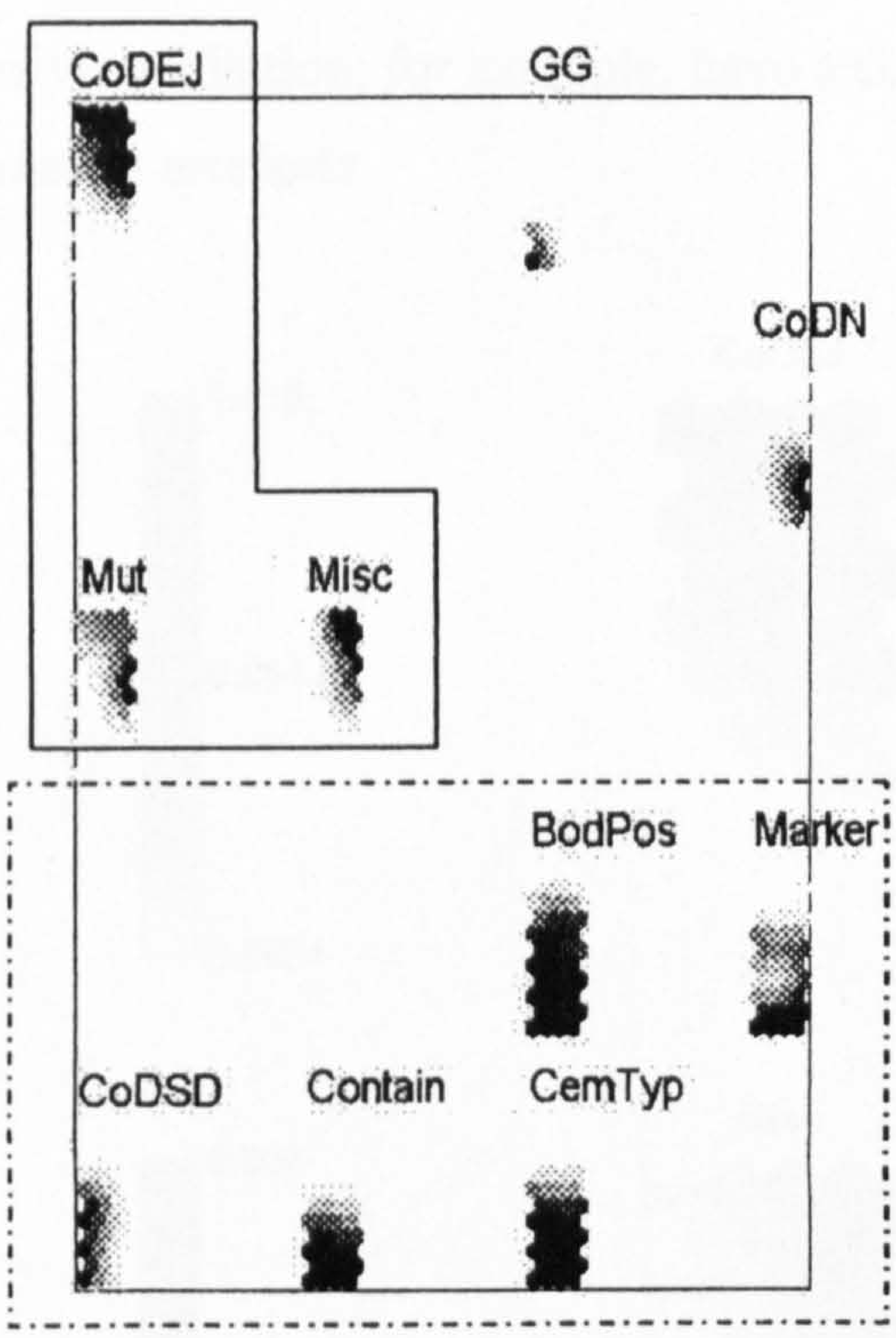


**Figure 6.25** Reorganised corresponding component planes for Spain data

The three different causes of death represented here possess different patterns of shading in their respective component planes. CoD-SD occupies the bottom left-hand corner of its plane, while CoD-N is in the bottom right-hand corner, hence indicating the cases that posses those traits occupy those opposing positions on the overall u-matrix – where the shading of the trait is, that is where the case that has that trait is.

The component planes representation indicates strong correlations for presence of a container, body position, and cemetery type, with a weaker correlation for marker. Conversely, CoD-EJ and miscellaneous artefacts (in this instance, rubbish) are located in their respective component planes opposite to the position of the normative container, indicating that extra-judicial death and the presence of rubbish do not correlate with normative burial traditions. This pattern in shading indicates opposing types of behaviour.

The u-matrix of the burial types map and three of the highly correlated variables are shown in Figure 6.26. Note that the cases from the Villaviciosa site have a high occurrence of miscellaneous artefacts and, conversely, the normative cases do not. The burials with extensive mutilation, for example, have a correspondingly high prevalence of miscellaneous artefacts.

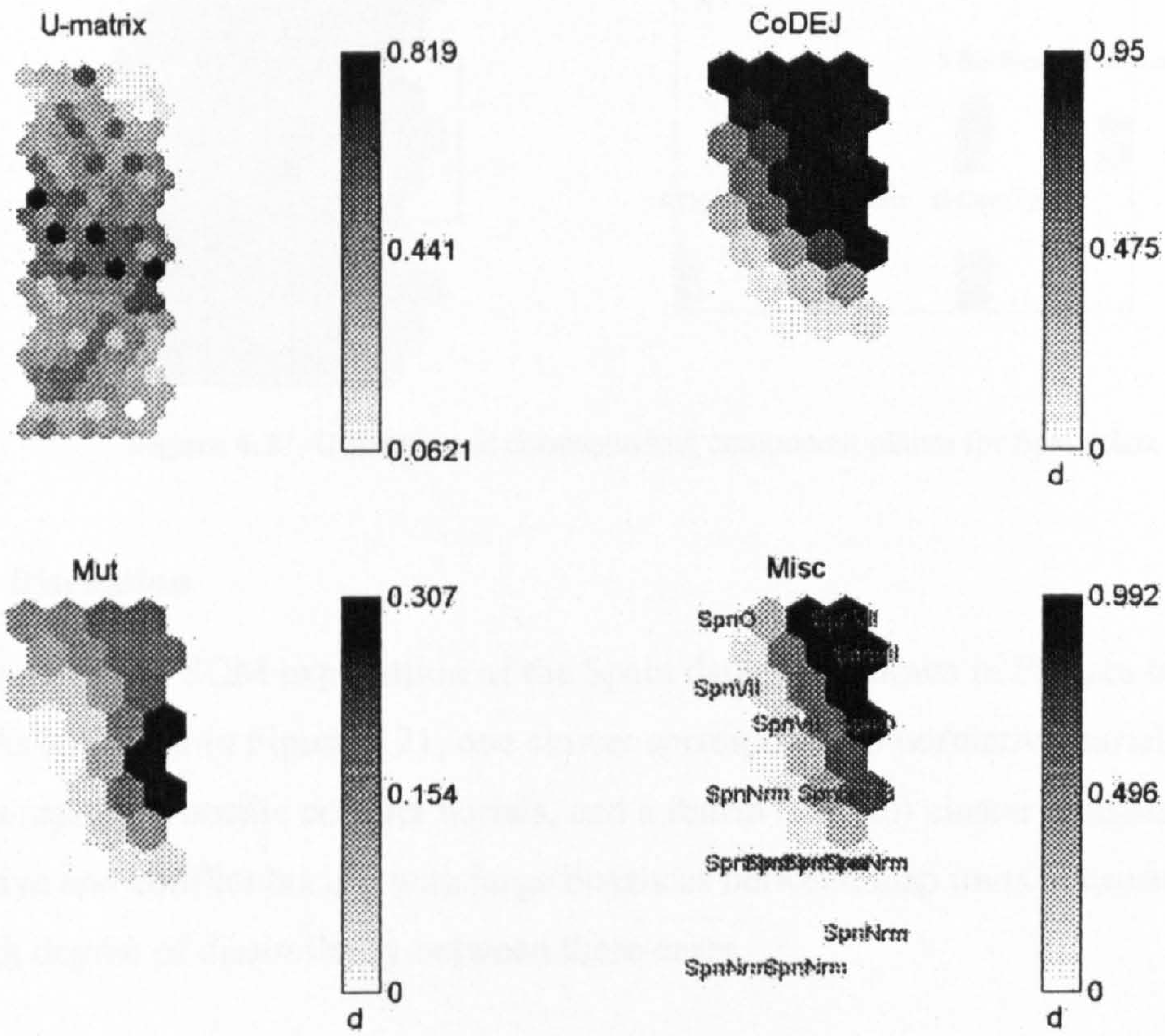


**Figure 6.26** U-matrix and three highly correlated component planes for Spain data

Component plane placement on the u-matrix indicates where the cases that posses that characteristic will be placed. The component planes for Misc. (miscellaneous by the presence of ritual markers (i.e. grave markers, grave goods, and miscellaneous artefacts not normally associated with burials).

The different projections used offer efficient ways to visualise data and new ways of extracting information from data. The SOM effectively represents correlations between body treatment and cause of death variables in the different general types of burial.

### 6.3.4 Korea Data

As with the Korean data discussed in Chapter 5, the Korea data used in the SOM analysis consists of the same 83 cases, 28 burials from 22 different locations from the Korean War (1950-1953), 28 cases of normative burials from South Korea and 27 normative burials from Yankton, South Dakota, both from the mid-20$^{th}$ century indicative of the normative behaviour of two of the primary cultures involved in the conflict represented by the conflict data[6] (for more information see Chapter 3). The Korean and American burials illustrate how one can tell the difference, statistically, between conflict burials and normative burials. Twelve of the 14 variables were used because two had zero variance (CoD-EJ and Mutilation). See Appendix D.3.7 for abbreviations used to identify variables.

The maps created from the Korean data by the SOM to identify burial types are of two types: u- and d-matrix clustering of the burial types (Figures 6.28 and 6.29); and the values of the component (variable) planes (Figures 6.31, 6.32, 6.33, 6.34, and 6.35). The simplest of these maps define clusters based on 12 variables. A more complex map was also created (Figure 6.30), with additional features, providing more subtlety to the distinctions.

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[6] Abbreviations used as labels to identify sites
Korea Kujan, P'yongan-Pukto Prov., North Korea (Conflict)
Skorea Sam Jong Don Village, South Korea (Normative)
Ynktn Yankton, SD, USA (Normative)

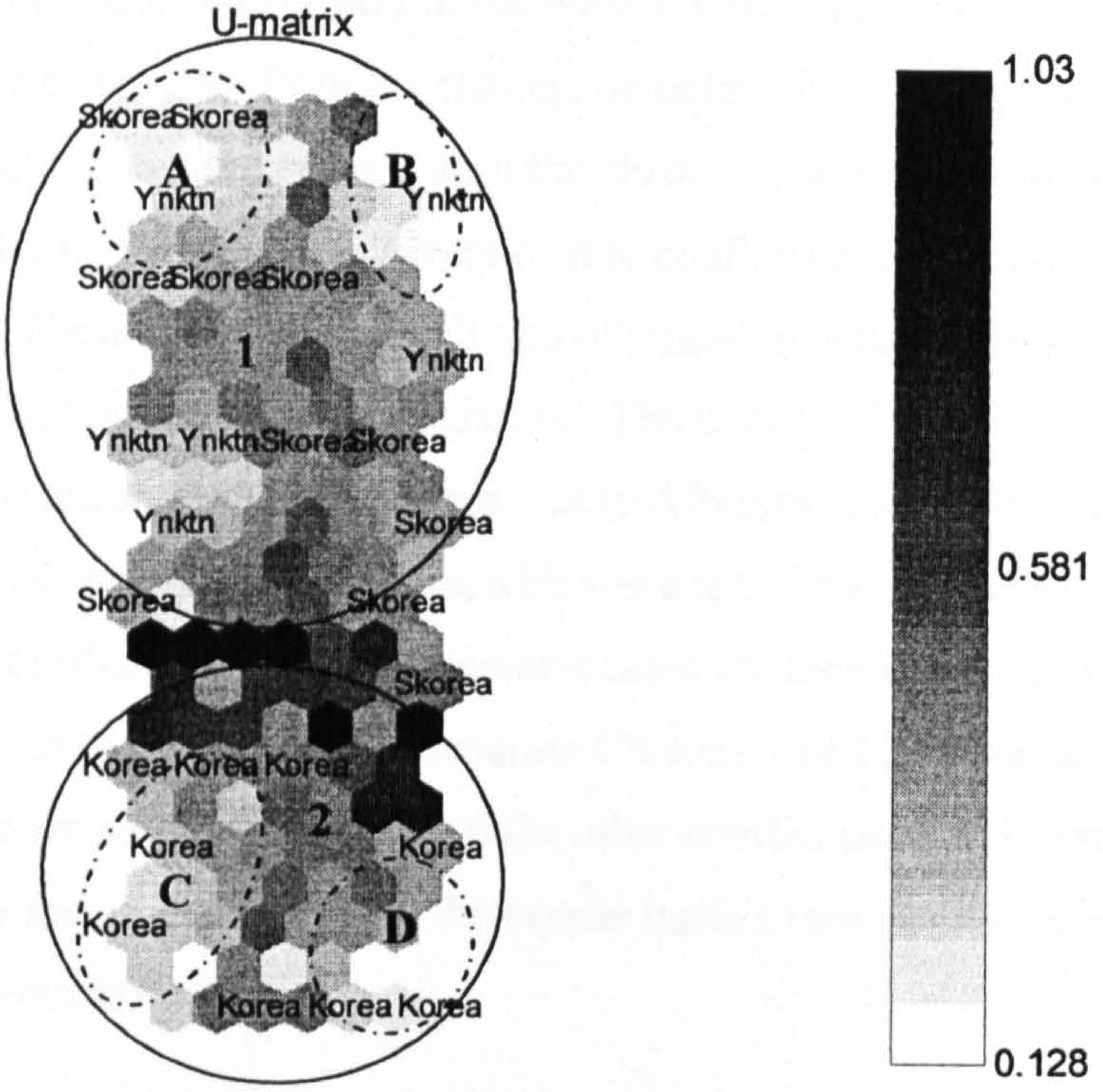


**Figure 6.28** U-matrix for Korea data (visually defined clusters circled)

## U-matrix

The u-matrix (Figure 6.28) broadly separates the normative burials at the top of the map from the conflict burials at the bottom of the map, with a scattered band of dissimilar cases separating the two broad types. The normative cluster (Cluster 1) has a majority of it uniformly shaded representing little distance (high similarity) between cases, but it does have two sub-clusters. The top right corner consists of a small area of very light coloured normative units; this sub-cluster is separated by some darker cases from the other sub-cluster on the top left corner. These clusters are separated by the presence of markers and grave goods in Cluster 1B, which can indicate differences in the degree of adherence to normative rituals possibly caused by different economic levels and the extent to which individuals could afford ritual markers, especially in the Yankton cemetery (see Table 6.4 for descriptions of the clusters).

Conversely, the conflict cluster at the bottom is comprised of varied distances among the cases represented by the high level of variation in the shades of grey with two distinct sub-clusters. The cluster in the bottom left corner (Cluster 2D) is not only distant (very dissimilar) from the clusters on either side – as represented by the scattered black ravine, but the cases within the cluster of rather dissimilar from each other. This cluster is made up of different hostile conflict cases from different areas in North Korea. These cases have a high rate of miscellaneous artefacts, while the cases in Cluster 2C show signs of obscuration. The burials of these two sub-clusters share the many of the same characteristics, but to different levels, which therefore places them within the larger cluster, but with some grey cases between them indicating distance (dissimilarity). The neutral cases are located at the top of Cluster 2, represented by the darker units that separate Clusters 1 and 2. This indicates that while these cases are somewhat similar to the other conflict cases in the sub-clusters in Cluster 2, they are also distant from the hostile burials (see Appendix H for individual case records).

| Cluster | Burial Type | Variable(s) |
|---|---|---|
| 1 | Norm | Civilian Status, CoD-SD, CoD-N, Clothing, Marker, Body Position, NormCemtery, Grave Goods |
| 1A | Norm | Civilian, CoD-SD, CoD-N, Body Position, NormCemtery |
| 1B | Norm | Civilian, CoD-SD, CoD-N, Clothing, Body Position, NormCemtery, Marker, Grave Goods |
| 2 | Conflict | Military Status, CoD-CR, Clothing, Misc. Artefacts, ObInt |
| 2C | Hostile | Military Status, CoD-CR, CoD-EJ, Clothing, ObInt |
| 2D | Hostile | Military Status, CoD-CR, Clothing, Misc. Artefacts |

**Table 6.4** Cluster assignment For Korea data. The cluster refers to areas marked on Figure 6.28

**D-matrix**

The d-matrix projection (Figure 6.29) indicates that most units belong to either normative or conflict general burial type with some cases in the centre, separating the two clusters. Again, this projection is clearer than the u-matrix in identifying two general burial types, but some of the more subtle variations are lost, such as the subtle differences among the cases in the conflict cluster (which are not as clearly defined here as in the u-matrix).

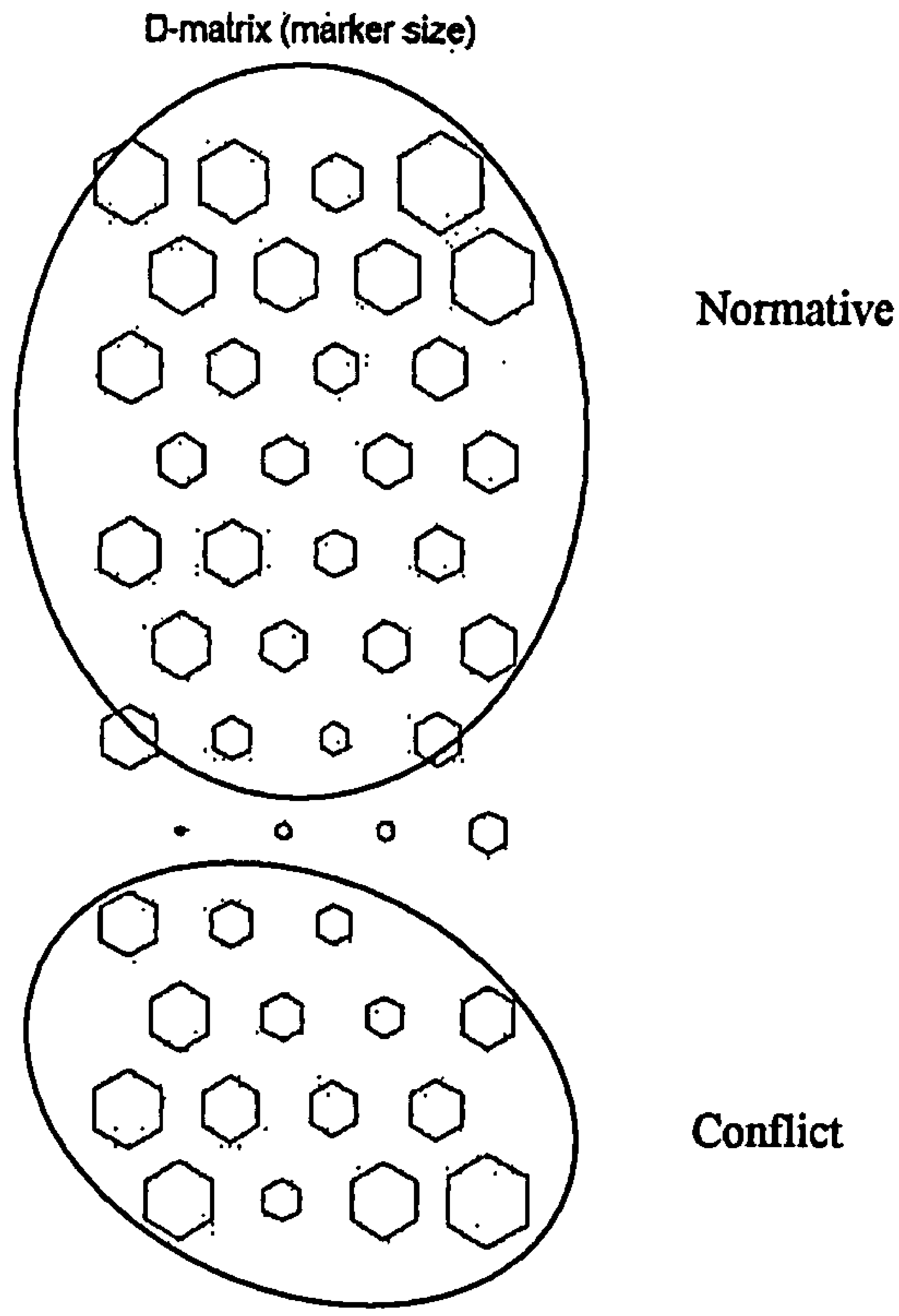


**Figure 6.29** Distance matrix or d-matrix (marker size) for Korea data (visually defined clusters circled)

**U-matrix and BMU**

Three types of burial are indicated in Figure 6.30. They are two normative clusters (based on the country South Korea, or U.S.), and one conflict cluster. By identifying the BMU for each cluster, this feature pinpoints the case that represents the centre of each cluster. There are several examples of two types of sites occupying the same unit in the u-matrix. For example, cases 31 and 78 from the normative South Korea dataset (identified by the black circle) occupying the same unit in the top left hand corner, but case 31 (represented by the outer green circle), is the case that represents the centre of that cluster, therefore the BMU. By virtue of the size of the coloured hexagon, it has a higher value than its immediate blue neighbour. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space. Case 31 represents the unit with the highest value in the normative cluster. Case 4 (from the North Korea conflict data) in the lower right hand corner represents the BMU for not only the cases in the 2D sub-cluster, but for all of the conflict cases.

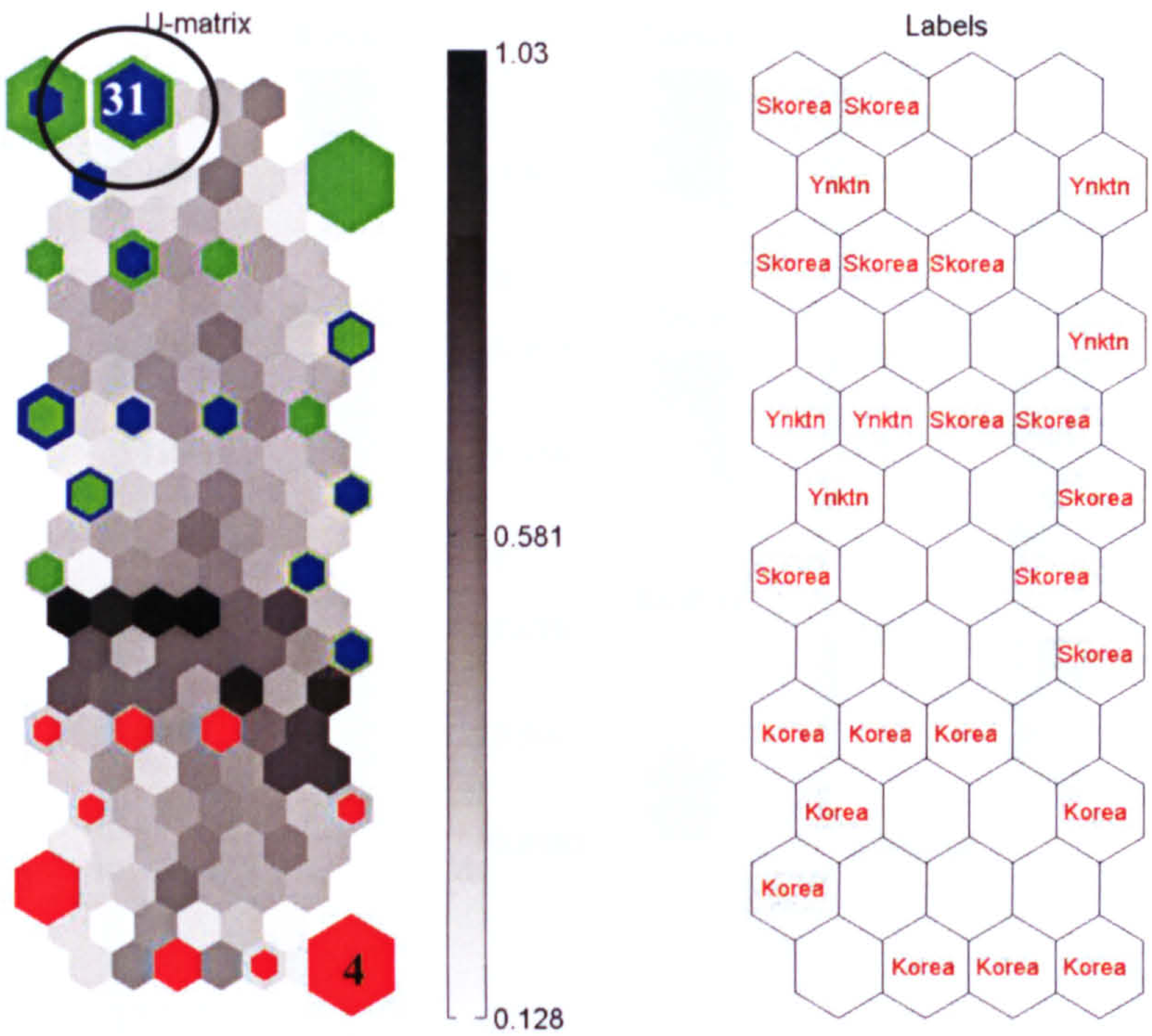


**Figure 6.30** U-matrix and corresponding labels and colour coded BMU's for Korea data (Blue: Yankton (Normative); Green: South Korea (Normative); and Red: Korea)

**Component Planes**

Figure 6.31 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.32, the component planes are reorganised.

In Figure 6.31, there are four component planes (Status, Contain, GG, and Misc.) that have very high scores, between 0.981 and 1, and very dark shading over 70% of their respective planes. This pattern in shading and the high scores indicate that these four variables strongly influenced the composition of the clusters. Conversely, the shade of the variable CemTyp is very light, indicating a very low value - a maximum of 0.245 on the value bar. Its position in the bottom left-hand corner of the plane indicates its correspondence with other variables sharing similar positions, such as the variable BodPos.

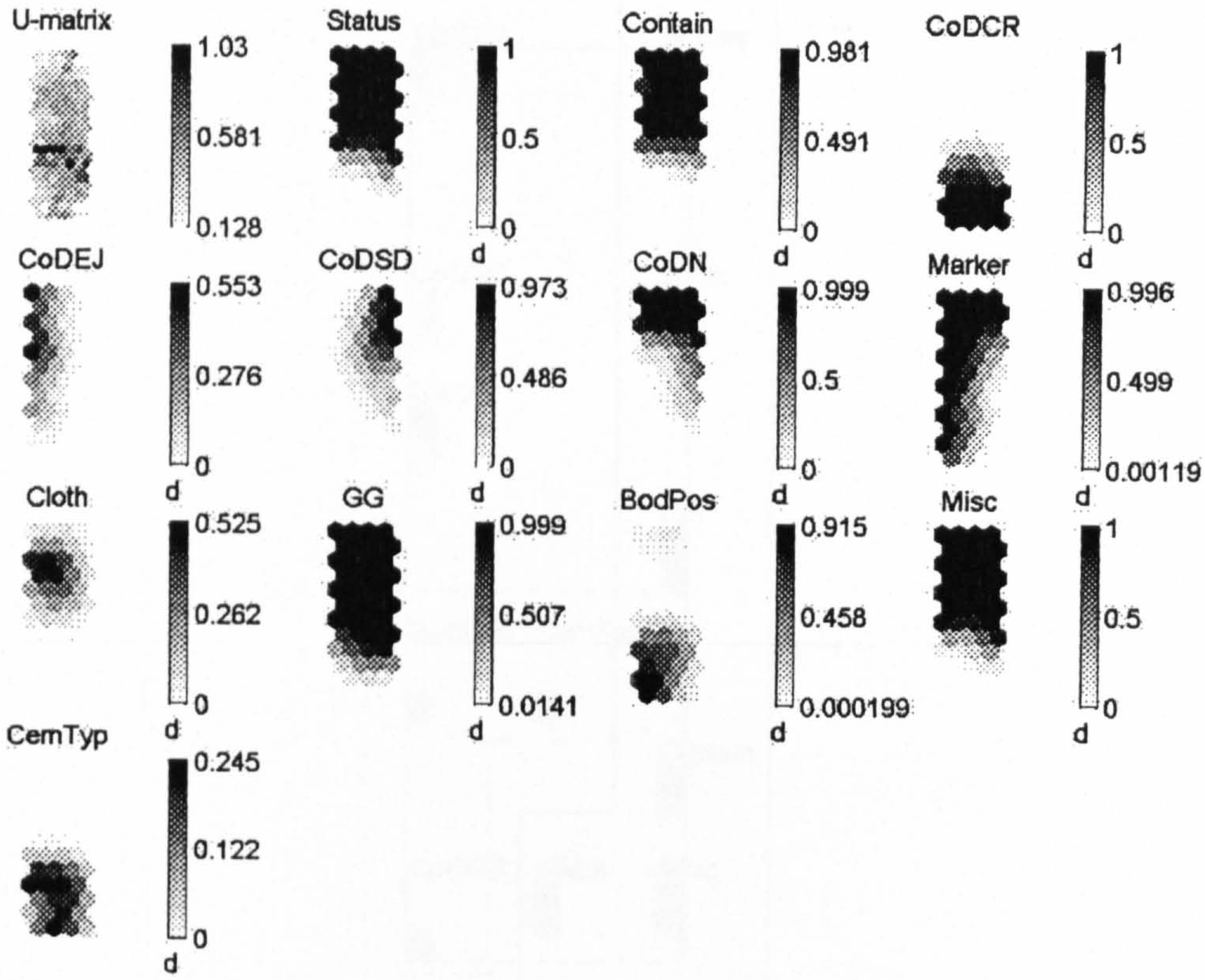


**Figure 6.31** U-matrix and component planes of all variables for Korea data

Shading patterns can visually indicate correlations and which variables are unlikely to be in the same burial. For example, the shading for BodPos is the opposite to that of Misc. In fact, there is a minimum of overlap, indicating mutually exclusive behaviour. This is also illustrated in the shading patterns for the causes of death. All four causes occupy different locations in their respective planes.

The second use of the component planes visualisation is identifying correlations. Correlations are indicated by a similarity in position of different variables within the matrix. The variables in Figure 6.32, for example, form two distinct groups. Contain, Marker, GG, Status, Cloth, and Misc. comprise one group, while the variables CoD-CR, BodPos, and CemTyp comprise another. The similarity of component planes in each group indicates that the variables are well correlated. Discussed below are eight highly correlated component planes corresponding to different burial behaviour.

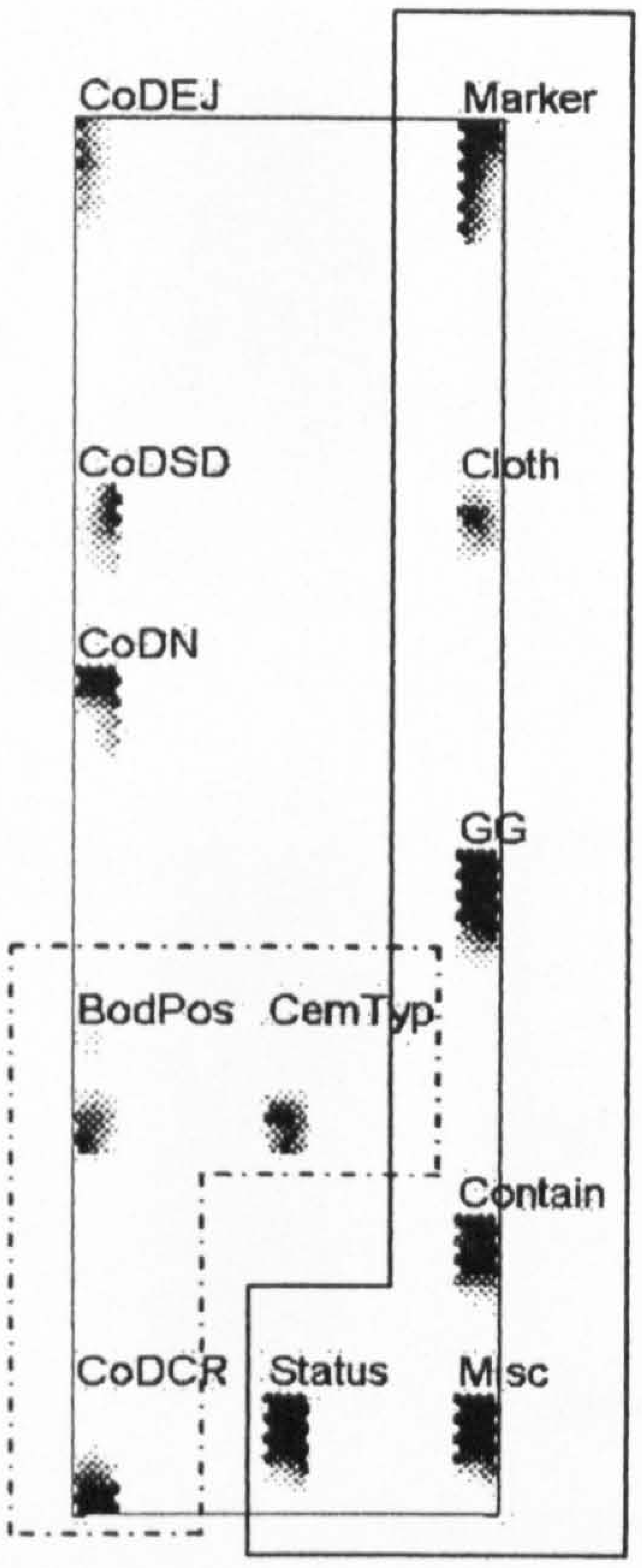


**Figure 6.32** Reorganised corresponding component planes for Korea data

Close-ups of two groups of correlated variables for normative and conflict burials are shown in Figures 6.33 and 6.34, respectively. The burials with GG, for example, have a correspondingly high prevalence of Markers.

A close-up of the five highly correlated normative variables is shown in Figure 6.33. It is interesting to note that the ritual markers have very similar shading patterns and almost identical values, thereby indicating that the burials with a normative container will have a correspondingly high prevalence of grave goods. In addition, the shading patterns and high values for each variable correspond to the location of the normative cases (as illustrated in the Status component plane labels). This confirms that the normative burials posses the expected ritual markers, as well as a cause of death that is considered normative (i.e. natural).

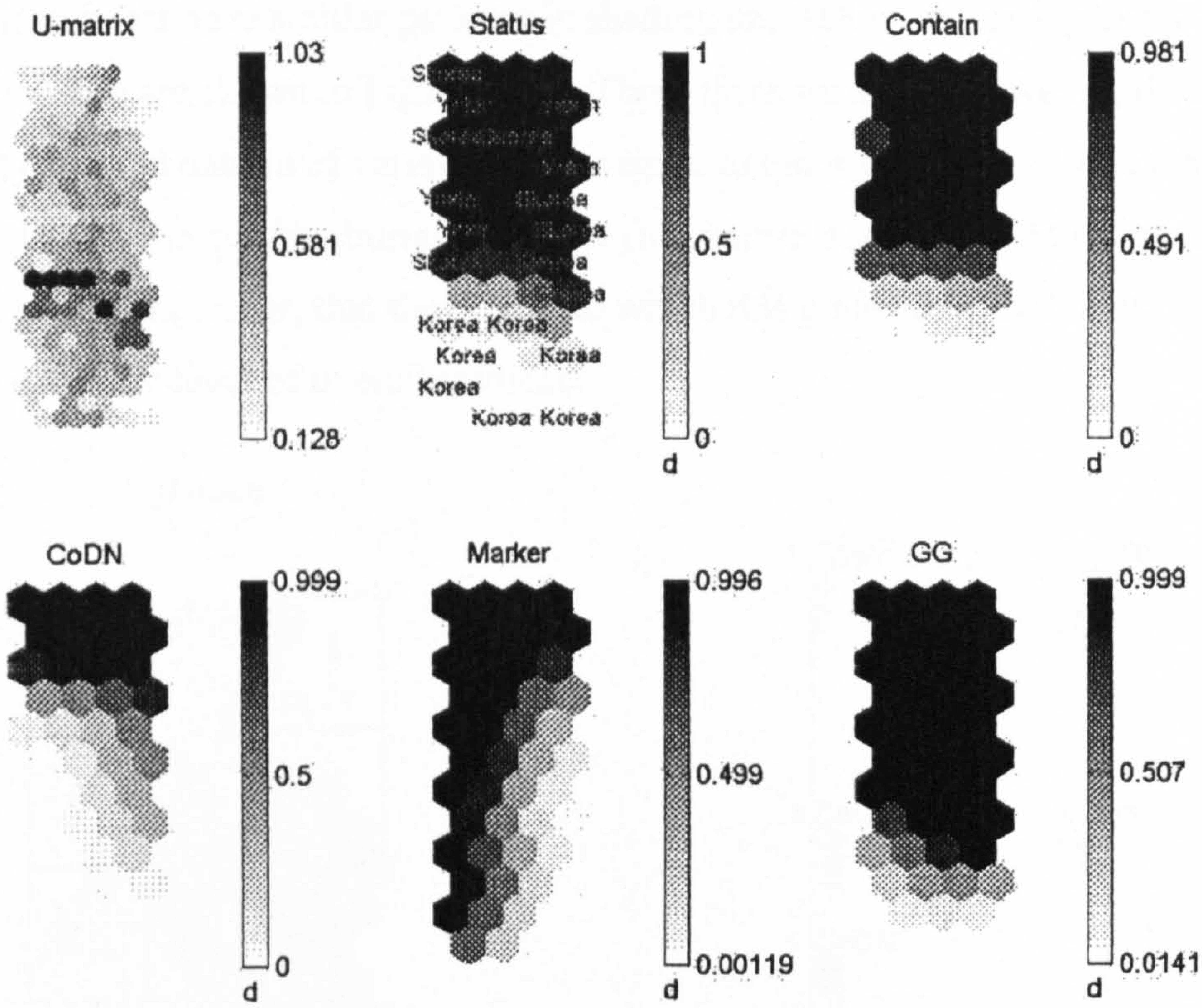


**Figure 6.33** U-matrix and five highly correlated component planes for Korea data

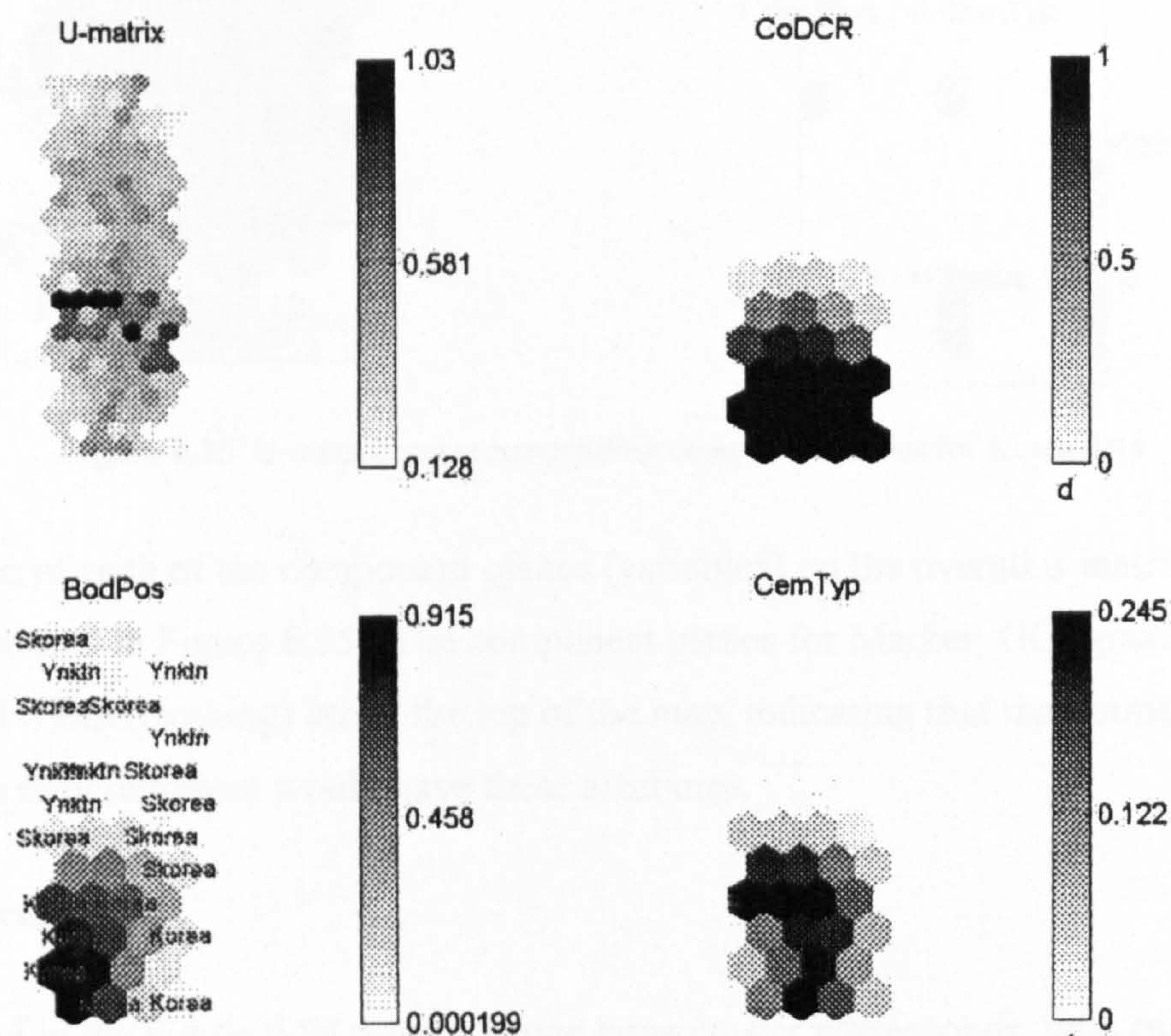


**Figure 6.34** U-matrix and three highly correlated component planes for Korea data

Three variables that have similar patterns in shading and values indicating a low-level relationship are shown in Figure 6.34. These three variables, however, do not follow the expected pattern of variables with regard to types of burial. While CoD-CR is consistent with conflict burials, BodPos (normative body position) is not. It is important to note, however, that the degree to which this plane is shaded does indicate a very low-level of overall influence.

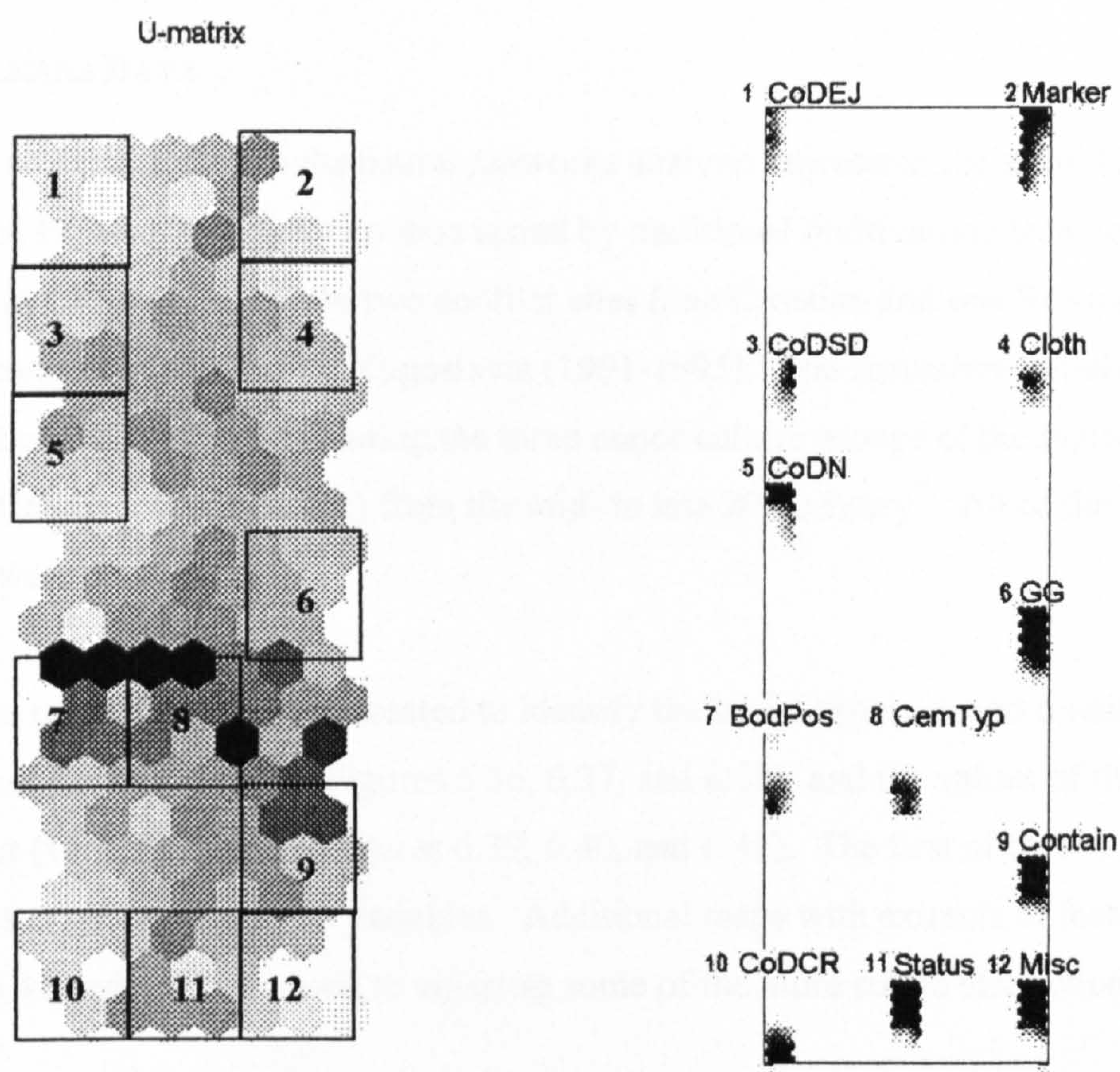


**Figure 6.35** U-matrix and corresponding component planes for Korea data

The location of each of the component planes (variables) on the overall u-matrix map is illustrated in Figure 6.35. The component planes for Marker, GG (grave goods), and Cloth (clothing) are at the top of the map, indicating that the normative burial cases they represent would have these attributes.

### 6.3.4.a Discussion

As indicated in the Figure 6.28 u-matrix, one large cluster corresponds, with two smaller sub-clusters, two normative burials, and one large cluster, also with two smaller sub-clusters, represent conflict burials. The conflict cluster had moderate distances between map units because there is a high degree of dissimilarity between these cases.

The SOM method using 12 of the 14 variables produced good differentiation of normative versus conflict burials as well as identifying varying degrees of agreement of hostile conflict burials.

### 6.3.5 Balkans Data

The Balkans dataset used in the neural networks analysis represents the same 119 cases as the Bosnian and Croatian data tested by traditional multivariate techniques discussed in Chapter 5: 31 from two conflict sites (one Croatian and one Bosnian) from the conflict in the Former Yugoslavia (1991-1995). The normative burials are comprised of 88 burials representing the three major culture groups of the region (Serbian, Croatian, and Bosniak) from the mid- to late 20th century[7]. All of the 14 variables were used.

Again, two types of maps were created to identify the burial types: u- and d-matrix clustering of the burial types (Figures 6.36, 6.37, and 6.38); and the values of the component (variable) planes (Figures 6.39, 6.40, and 6.43). The first of these maps define clusters based on the 14 variables. Additional maps with extracts of features (Figures 6.41 and 6.42) are used to visualise some of the more subtle distinctions.

#### U-matrix

The u-matrix of the SOM of the Balkans data is shown in Figure 6.36. The clustering nicely splits the SOM into two main parts, which are of a size proportionate to the number of cases in the respective types of data, normative and conflict burials, with a distinct black band of cases separating them. Further examination of the two broad burial types identifies three sub-clusters.

[7] Abbreviations used as labels to identify sites
Bosnia Bosanski Petrovac, Bosnia-Herzegovina (Conflict)
Croat Pakračka Poljana, Croatia (Conflict)
SerbN Tenkovo, Serbia (Normative)
CroatN Slovanski Samac, Croatia (Normative)
BosN Ricica, Bosnia-Hercegovina (Normative)

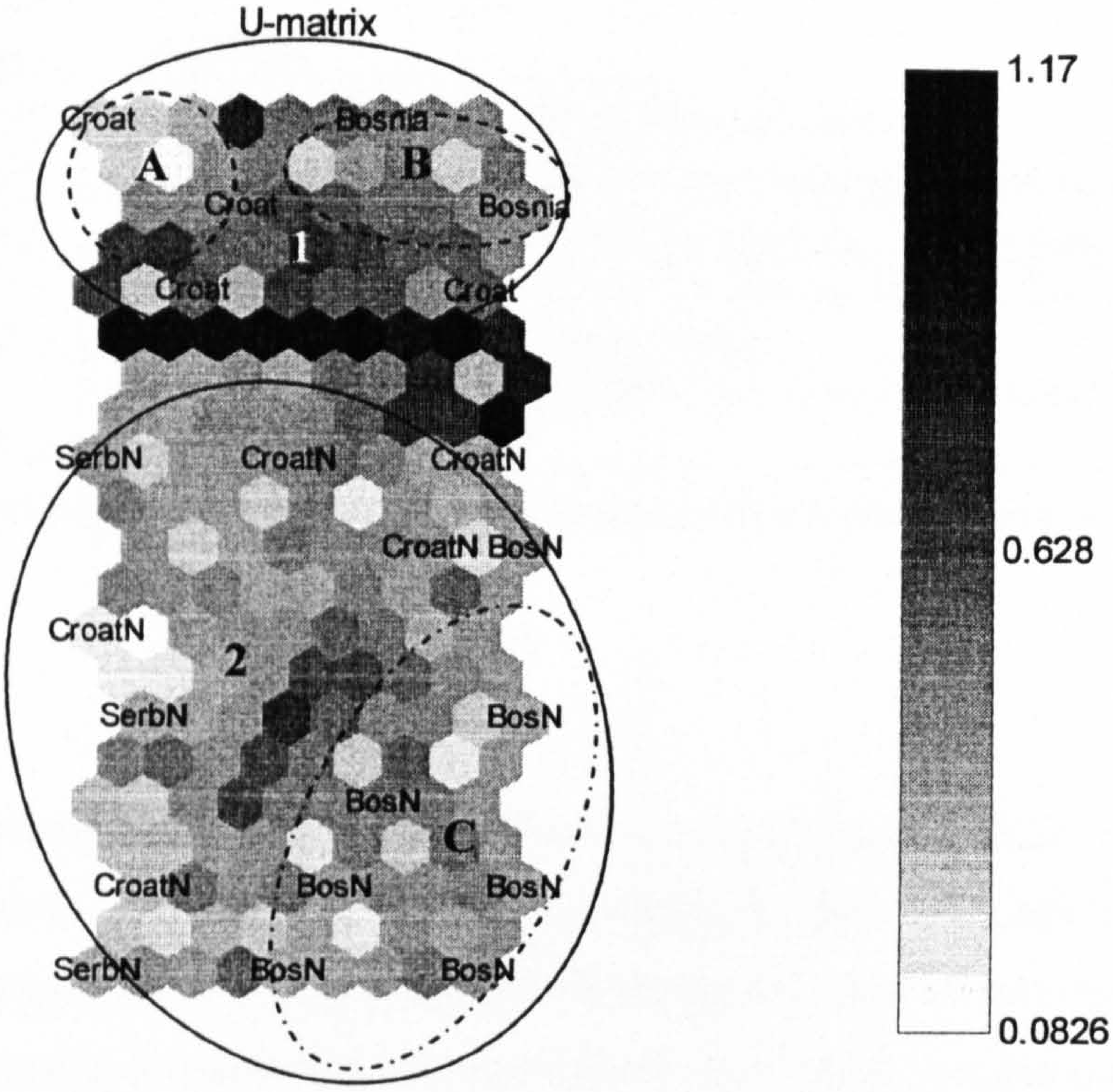


**Figure 6.36** U-matrix for Balkans data
(visually defined clusters circled)

The normative cluster (Cluster 2) is uniformly shaded, representing little distance (high similarity) between cases; however, there is an identifiable, slightly distant, sub-cluster comprised of normative Bosnia burials (see Appendix H for individual case records). Conversely, the conflict cluster and the two sub-clusters at the top have varied distances in each cluster represented by the high level of variation in the shades of grey. The top right corner consists of a small area of very light coloured conflict units; this cluster is separated by some darker cases from the other conflict cluster on the top left corner.

Significantly, each conflict cluster on the top of the map is comprised of cases from different sites within the Balkans dataset (Croat (Cluster 1A) and Bosnia (Cluster 1B)). The two conflict sub-clusters can be divided based on status, while the normative cluster has a sub-cluster based on the presence of clothing (see Table 6.5 for descriptions of the clusters). This separation indicates that while there is some similarity between Clusters 1A and 1B, the behaviours exhibited are distinct enough to classify the cases as different.

| Cluster | Burial Type | Variable(s) |
|---|---|---|
| 1 | Hostile | CoD-EJ, Mutilation, Clothing, Misc.Artefacts |
| 1A | Hostile | Civilian Status, CoD-EJ, Mutilation, Clothing, Misc.Artefacts |
| 1B | Neutral | Military Status, CoD-EJ, CoD-CR, Clothing, Misc.Artefacts |
| 2 | Norm | Civilian Status, CoD-SD, CoD-N, Clothing, Marker, Container, Body Position, NormCemtery, Grave Goods |
| 2C | Norm | Civilian Status, CoD-SD, CoD-N, NormCemtery, Marker, Body Position, Container |

**Table 6.5** Cluster assignment for Balkans Data. The cluster refers to areas marked on Figure 6.36

## D-matrix

The general normative and conflict burial types are clearly separated in the d-matrix projection (Figure 6.37) with some cases (represented by the small marker size) near the top separating the two clusters. It also defines the two conflict sub-clusters. While this projection is clearer than the u-matrix in identifying two general burial types, the slight difference in the normative Bosnia burials from the other normative burials is not as apparent in this map.

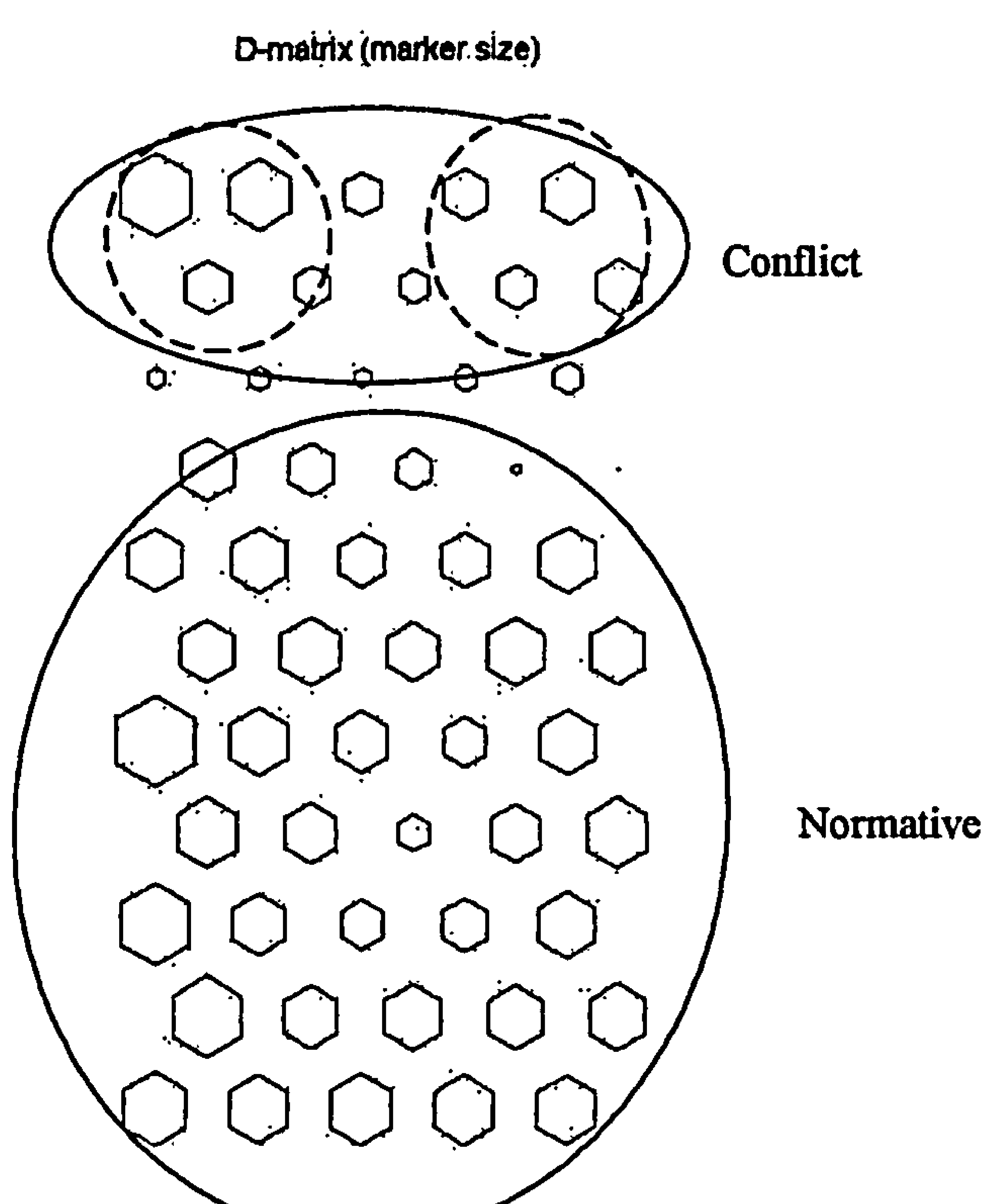


**Figure 6.37** Distance matrix or d-matrix (marker size) for Balkans data (visually defined clusters circled)

**U-matrix and BMU**

The u-matrix, with coloured BMU's, isolates the same three burial types as above, e.g. normative cluster and the two conflict sub-clusters. In this map (Figure 6.38), there are a number of empty units, especially among the normative cases. This highlighting feature pinpoints the case that represents the centre of each cluster, thereby indicating the ideal representation of the cluster. For example, in Figure 6.38, case 2, a burial from the Bosnia site (by virtue of the size of the coloured hexagon) has a higher value than its immediate red neighbour. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space. For the Croat site, case 13 represents the case with the highest value of component planes. Cases 36, 60, and 137 represent the units with the highest value in the normative cluster (Serb norm, Croat norm, and Bosniak norm, respectively).

As well as identifying the BMU's for the map, the colour coding separates the different sites. The normative cases are blue, while the conflict cases are green and red (Croatia and Bosnia sites, respectively). This highlights the separation of the two general burial types, while at the same time, indicating the differences in the two conflict sites.

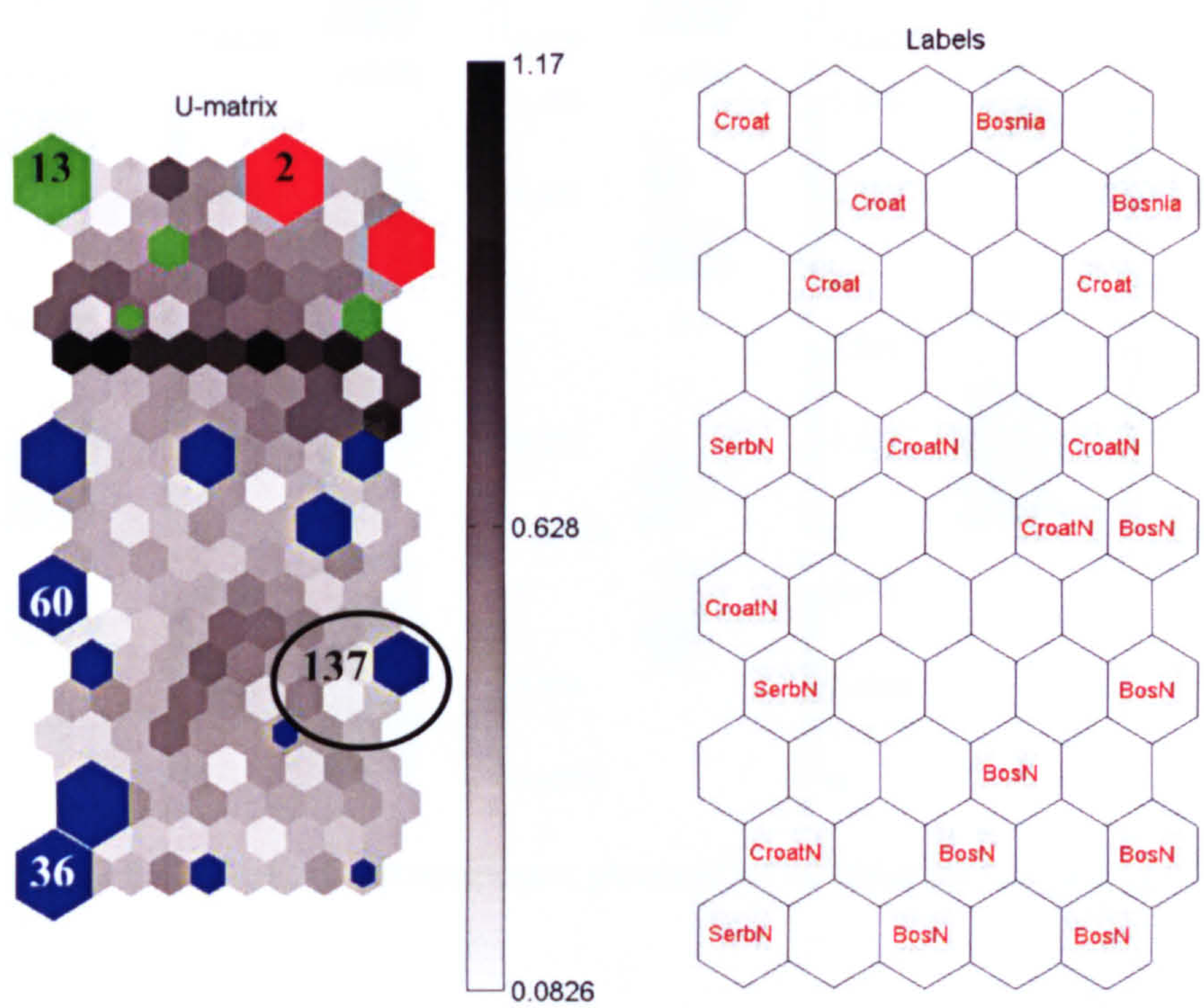


**Figure 6.38** U-matrix and corresponding labels and colour coded BMU's for Balkans data (Blue: Normative; Green: Croatia; and Red: Bosnia)

**Component Planes**

Figure 6.39 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.40, the component planes are reorganised.

In Figure 6.39 the shade of the variable ObInt (intentional obscuration) is very light, indicating a very low value - a maximum of 0.158 on the value bar. Its position in the bottom right-hand corner of the plane indicates its correspondence with other variables sharing similar values. Conversely, the variable Contain is very dark with over 65% of the plane having a value of 1 (note that the value bar on the u-matrix indicates distance, whereas the value bar on the component planes indicates the spread). Considered together, these representations indicate a high number of individuals in a container and a low number of obscuration in this particular dataset. Furthermore, the location of the higher value shading of ObInt is in opposition to that of Contain, suggesting that these two variables would not be present in the same clusters (see Appendix D.3.7 for abbreviations used to identify variables).

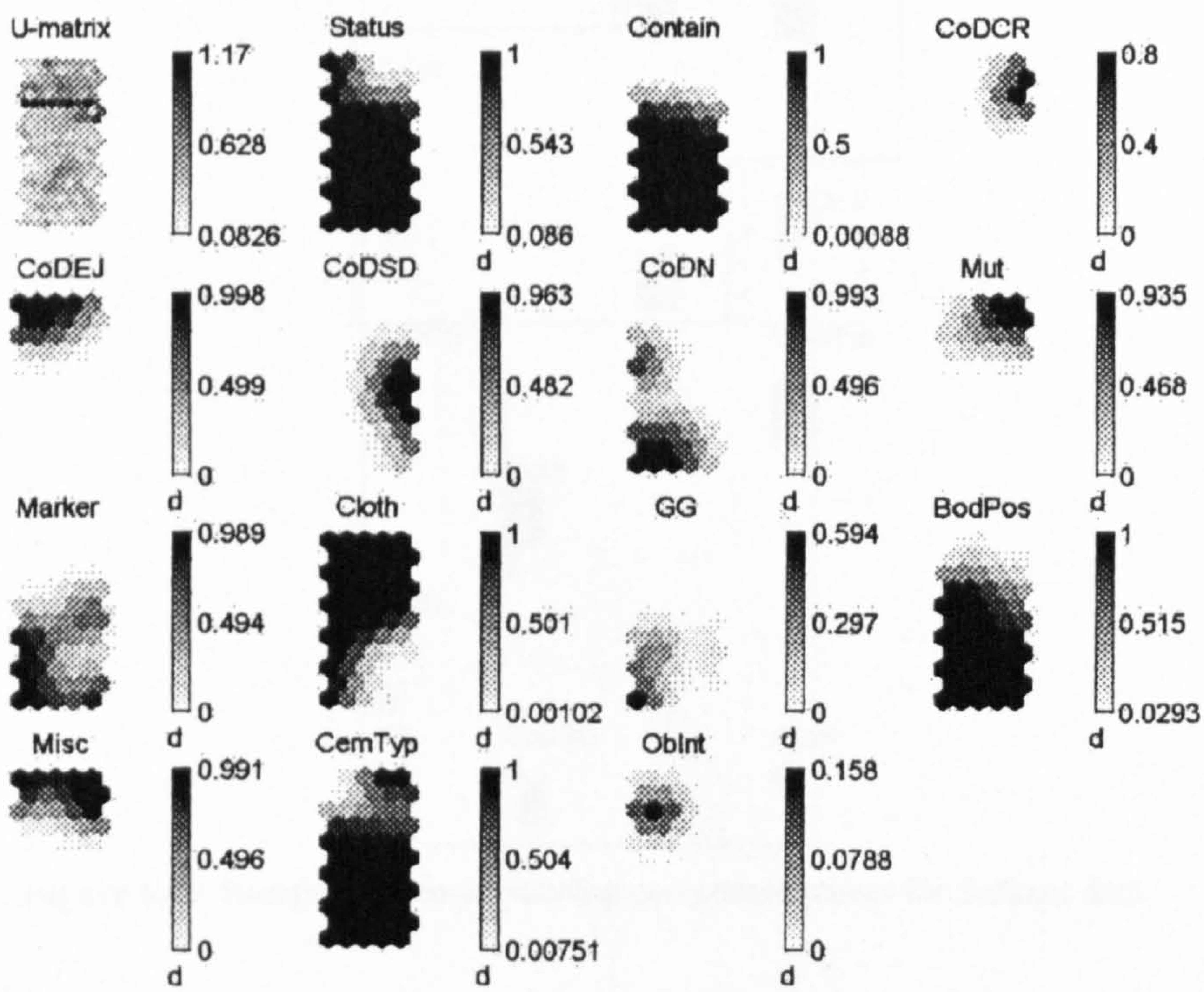


**Figure 6.39** U-matrix and component planes of all variables for Balkans data

Additional (negative) patterns in correlations are apparent. For example, the shading for BodPos is the opposite to that of Mut. In fact, there is a minimum of overlap, so much so that the shading for Mut could fit in the white areas of the BodPos, thus indicating mutually exclusive behaviour. This is also illustrated in the shading patterns for Status and CoD-CR; they occupy different locations in their respective planes. One thing to note is that conflict burial behaviours form consistent clusters in the map as do normative variables; these correlations are illustrated in Figures 6.41 and 6.42.

Reorganising the component planes visualisation is another method for identifying correlations. Correlations are indicated by a similarity in position of different variables within the matrix. The variables in Figure 6.40, for example, form two distinct groups. Contain, Marker, BodPos, and Status comprise one group, while the variables CoD-EJ, Mut and Misc. comprise another. The similarity of component planes in each group indicates that the variables are well correlated. What the spatial positioning of each variable means is discussed below.

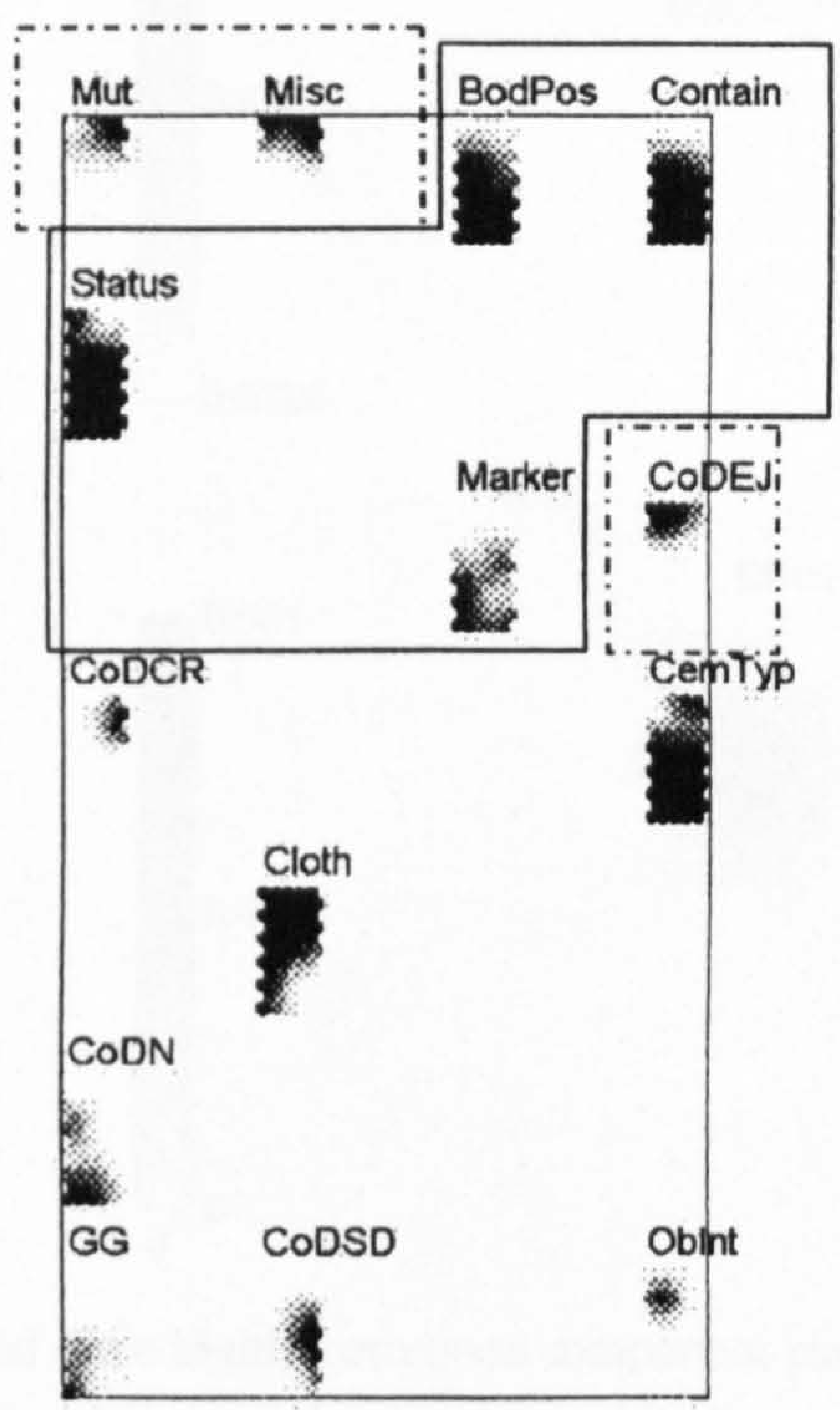


**Figure 6.40** Reorganised corresponding component planes for Balkans data

The component planes indicate strong correlations for Container, BodPos and Status, with a weaker correlation to marker (Figure 6.40). Conversely, CoD-EJ and Misc. Artefacts occupy the opposite location in their respective component planes to that of normative container, suggesting that these variables would not be associated with normative containers. This pattern of opposing value placement extends to the other variables as well. It can be noted that the three different causes of death represented here possess different patterns in their respective component plane; CoD-SD, for example, occupies the bottom left-hand corner of its plane, while CoD-EJ is near the top-left hand corner.

Close-ups of two groups of highly correlated variables for conflict and normative burials are shown in Figures 6.41 and 6.42, respectively. Note that the cases from the Croat site have a high prevalence of miscellaneous artefacts (Misc.) and conversely, the normative cases do not. The burials with CoD-EJ, for example, have a correspondingly high prevalence of intentional obscuration (ObInt).

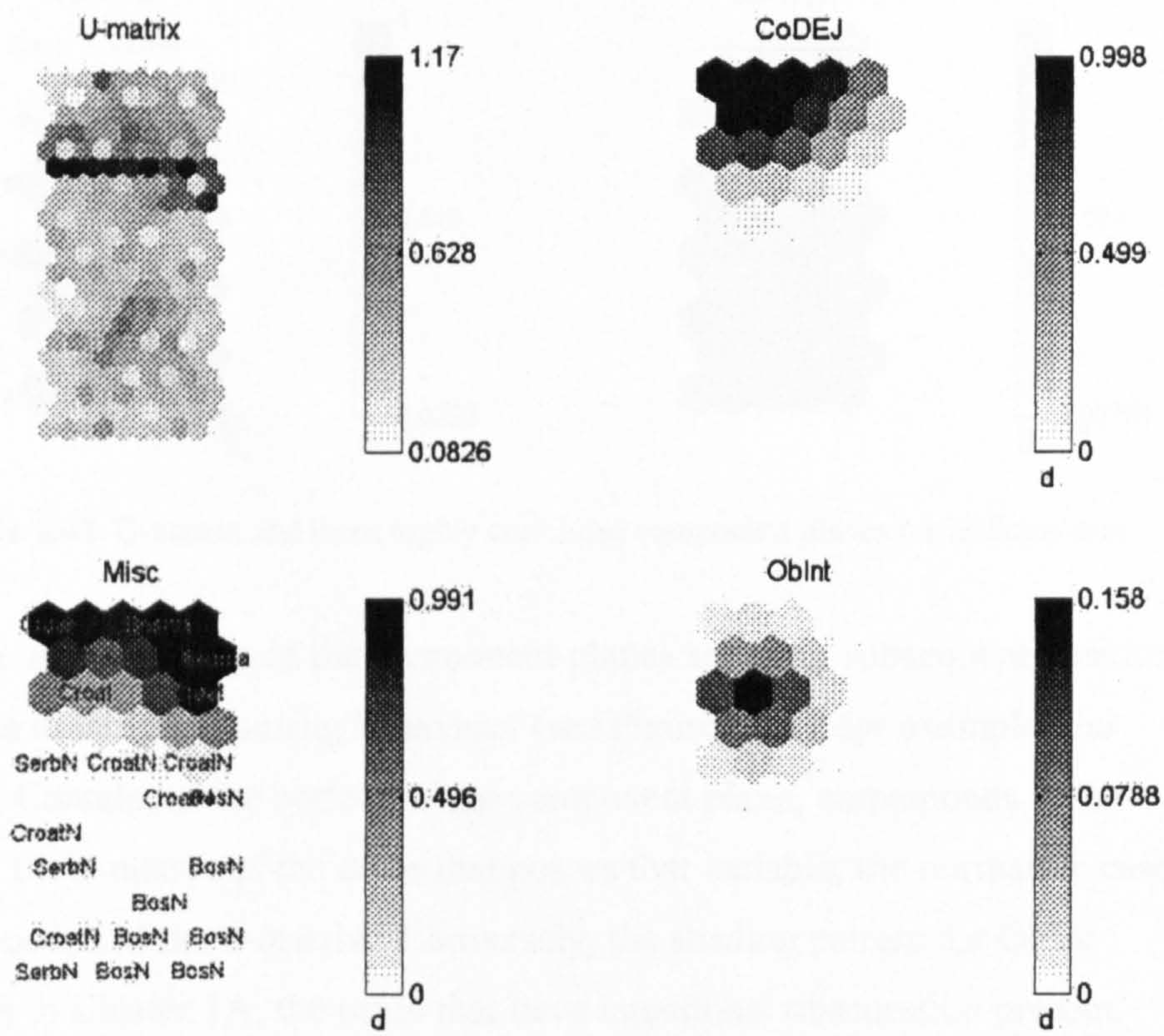


**Figure 6.41** U-matrix and three highly correlated component planes for Balkans data

Three variables that have similar patterns in shading and values that correspond to behaviour in normative cases are shown in Figure 6.42. Note that the cases from the normative sites have high rates of normative cemetery and body position and the presence of container. In addition, the shading patterns and high values for each variable correspond to the location of the normative cases (as illustrated in the

BodPos component plane labels). This suggests that the normative burials that possess a container will be placed in a normative body position and located in a normative cemetery.

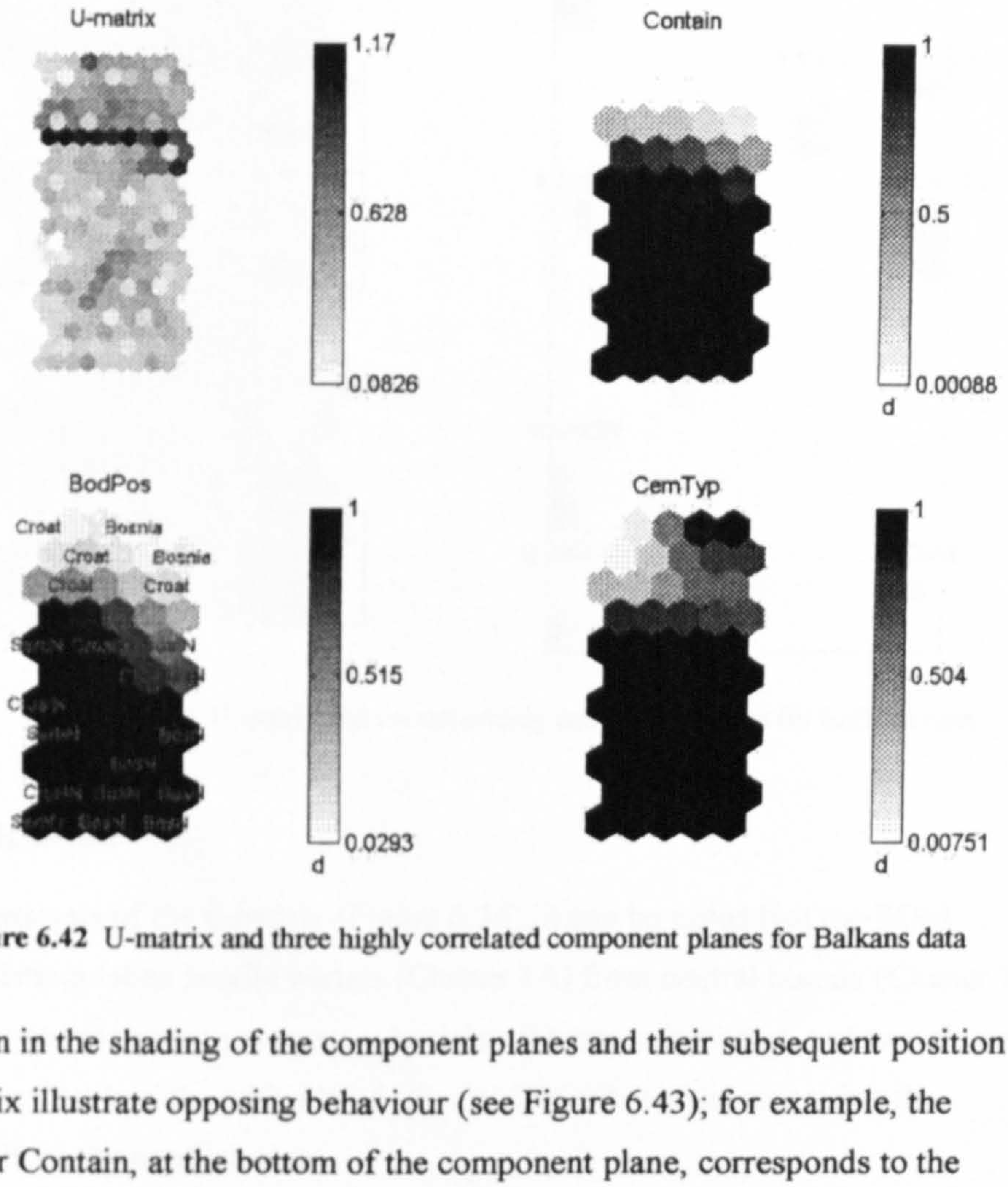


**Figure 6.42** U-matrix and three highly correlated component planes for Balkans data

The pattern in the shading of the component planes and their subsequent position on the u-matrix illustrate opposing behaviour (see Figure 6.43); for example, the shading for Contain, at the bottom of the component plane, corresponds to the location on the u-matrix of the cases that posses that variable, the normative cases on the lower portion of the u-matrix. Conversely, the shading pattern for ObInt corresponds to Cluster 1A, the cases that have intentional obscuration present.

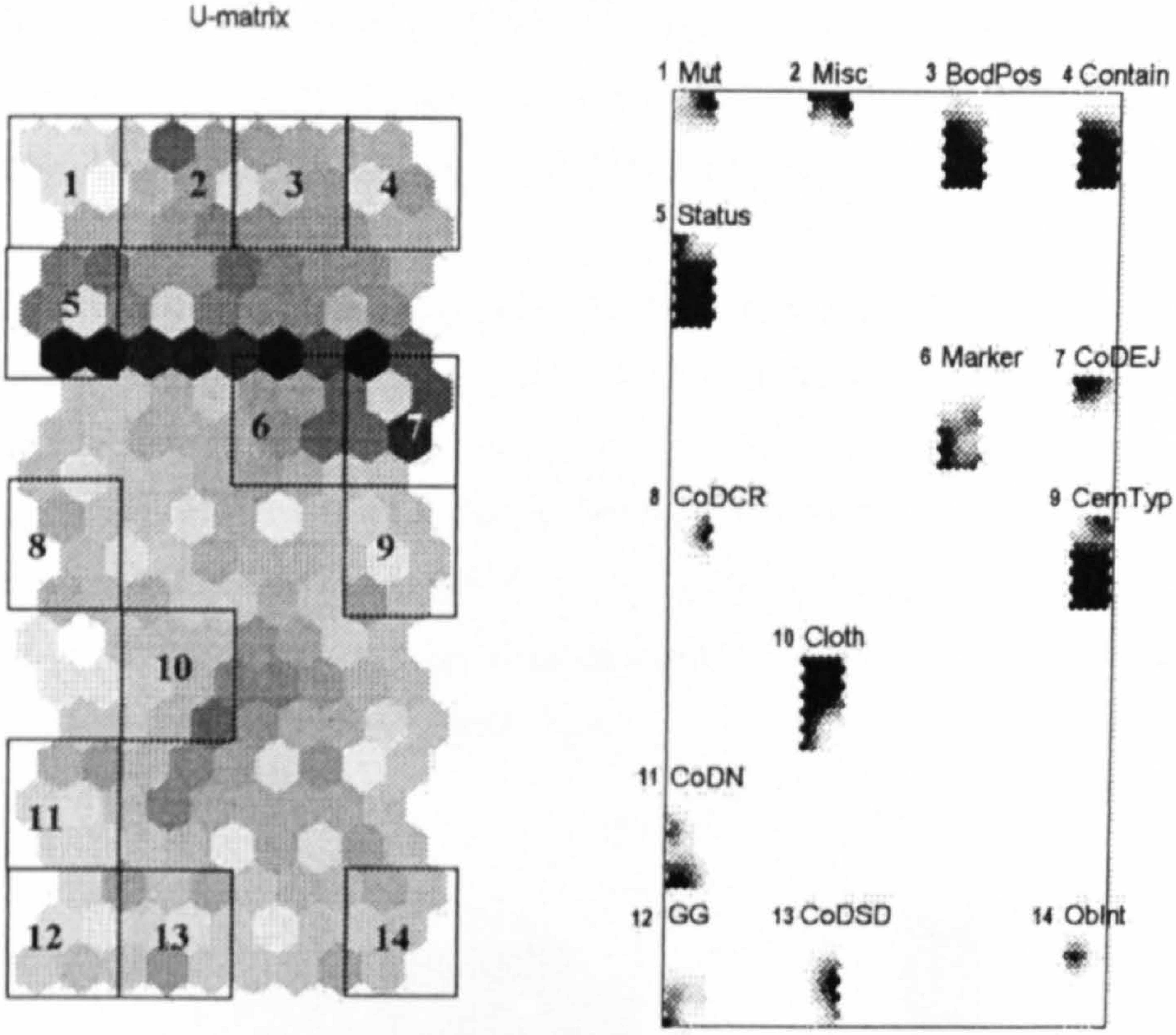


**Figure 6.43** U-matrix and corresponding component planes for Balkans data

### 6.3.5.a Discussion

From the analysis of the u-matrix (Figure 6.36), it can be noted that the SOM correctly distinguished hostile burials (Cluster 1A) from neutral burials (Cluster 1B). One cluster corresponds to normative burials with one sub-cluster, and two clusters represent conflict burials, with a band of very dissimilar cases separating the normative from the conflict cases.

The SOM method using the 14 variables produced good differentiation of normative versus conflict burials, based on clusters primarily determined by the presence of ritual markers (i.e. grave markers, grave goods, and miscellaneous artefacts).

### 6.3.6 19TH CENTURY NORTH AMERICAN DATA

This dataset is the same as the 19th century North America dataset discussed in Chapter 5: 91 cases, of which 52 are from four conflict sites from different time periods (1812-1814, 1861-64, 1876). The remaining 34 cases represent normative burials from a Methodist cemetery in Ontario from the early to mid-19th century[8] (for more information, see Chapter 3). Twelve of the 14 variables were used because two had zero variance (CoD-EJ and Obscuration).

The SOM created two types of maps to illustrate clusters and patterns in the 19th century North America data. These maps are u- and d-matrix clustering of the burial types (Figures 6.44 and 6.45). The component plane representations illustrate location patterns and values of the component (variable) planes (Figures 6.47, 6.48, 6.49, 6.50, and 6.51). These maps were defined using the 12 variables. One additional map (Figure 6.46), which included the location of BMU's, was created to provide more subtle detail to the distinctions.

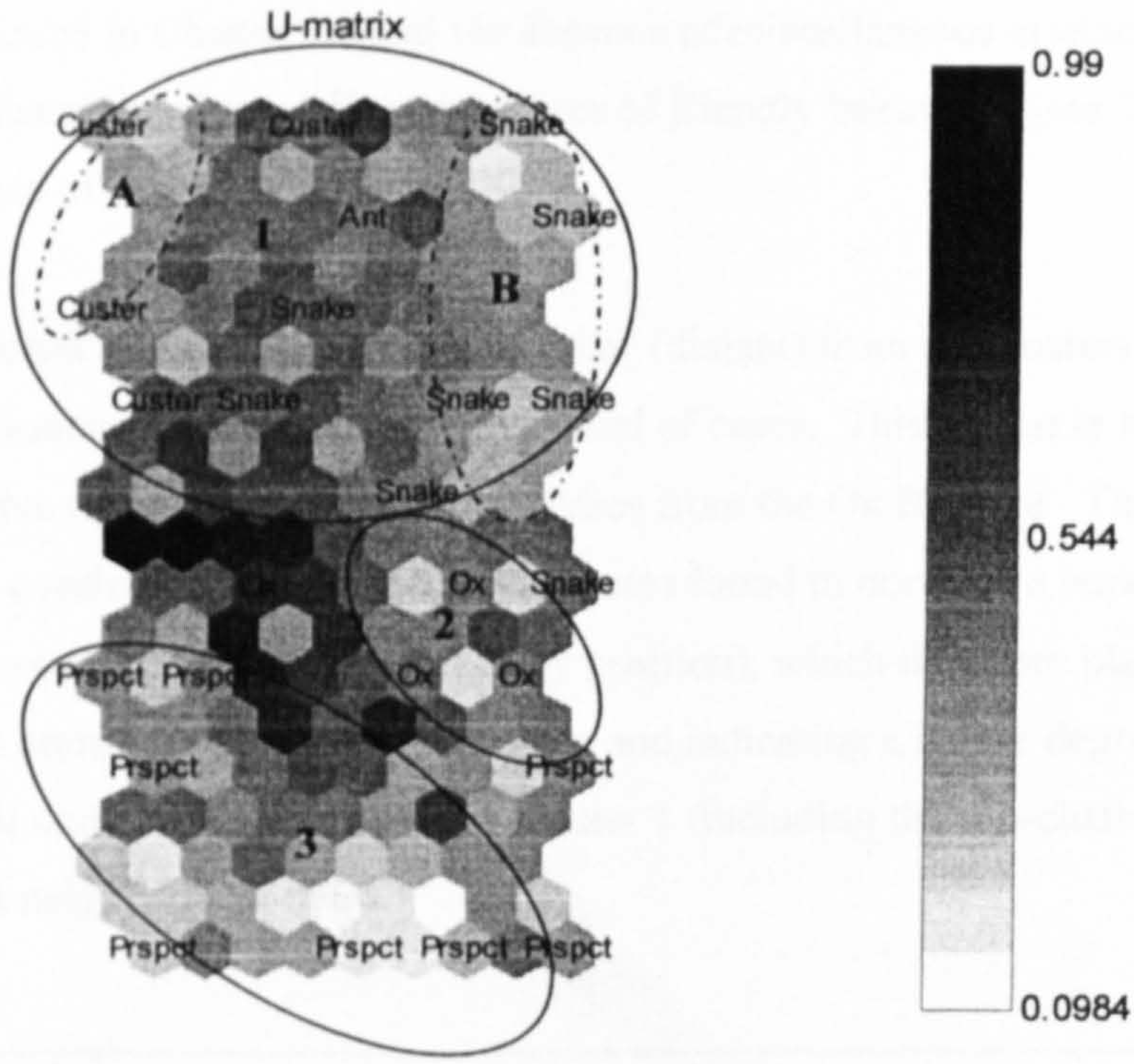


**Figure 6.44** U-matrix for 19th Century North America data (visually defined clusters circled)

---

[8] Abbreviations used as labels to identify sites

| | |
|---|---|
| Ant | Antietam, Maryland, USA (Conflict) |
| Custer | Little Big Horn Cemetery, Montana, USA (Conflict) |
| Ox | Ox Hill, Virginia, USA (Conflict) |
| Snake | Snake Hill, Fort Erie, Ontario (Conflict) |
| Prspct | Prospect Hill, Ontario, Canada (Normative) |

**U-matrix**

The most basic u-matrix (Figure 6.44) separates the normative burials at the bottom of the map from the conflict burials at the top of the map, with a roughly scattered cluster in the centre (see Appendix H for individual case records). Three separate areas can be picked out of the u-matrix that corresponds to variations within the broader normative and conflict categories. The normative Cluster 3 is uniformly shaded representing a high degree of similarity between cases. There are two sub-clusters within the larger conflict cluster (Cluster 1). These two sub-clusters have subtle variations on the broader conflict burial theme. The top right corner consists of a small area of very light coloured conflict units; this cluster is separated by a band of darker cases from the other conflict cluster on the top left corner. The band that separates these two clusters lacks the presence of the variables Mut, CemTyp, and Marker found in Cluster 1A and the absence of miscellaneous artefacts in Cluster 1B illustrating three different degrees of friendly behaviour (see Table 6.6 for descriptions of the clusters).

The centre cluster (Cluster 2) is very dissimilar (distant) from the clusters on either side – as represented by the scattered grey band of cases. This cluster is made up of some normative cases and the six conflict cases from the Ox Hill site. The cases at the latter site consistently contain some attributes found in normative burials (i.e. presence of a container and normative body position), which therefore places them between both normative and conflict clusters and indicating a higher degree of friendly burial compared to the cases in Cluster 1 (including the sub-clusters) and distance from neighbouring cases.

| Cluster | Burial Type | Variable(s) |
|---|---|---|
| 1 | Friendly | Military Status, CoD-CR, Clothing, Misc.Artefacts, Body Position |
| 1A | Friendly | Military Status, CoD-CR, Mutilation, Marker, Clothing, Misc.Artefacts, Norm Cemetery |
| 1B | Friendly | Military Status, CoD-CR, Clothing, Body Position |
| 2 | Friendly | Military Status, CoD-CR, Clothing, Container, Body Position, Misc.Artefacts |
| 3 | Norm | Civilian Status, CoD-SD, CoD-N, Norm Cemetery, Container, Body Position, Marker, GG |

**Table 6.6** Cluster assignment for 19th Century North America Data. The cluster refers to areas marked on Figure 6.44

**D-matrix**

The d-matrix projection (Figure 6.45) reproduces the same information as illustrated by the u-matrix in that it separates the normative burials from the conflict burials. Most units belong to one of the two general areas on the map that corresponds to the two general burial types with a smaller cluster in the top left corner of the map – separated by a thin band of cases (represented by the smaller markers). As with several of the d-matrices described above, this projection is clearer than the u-matrix in identifying two general burial types, but some of the more subtle variations are lost, such as the marked differences among the Ox Hill cases in the centre (which are not as clearly defined here as in the u-matrix).

D-matrix (marker size)

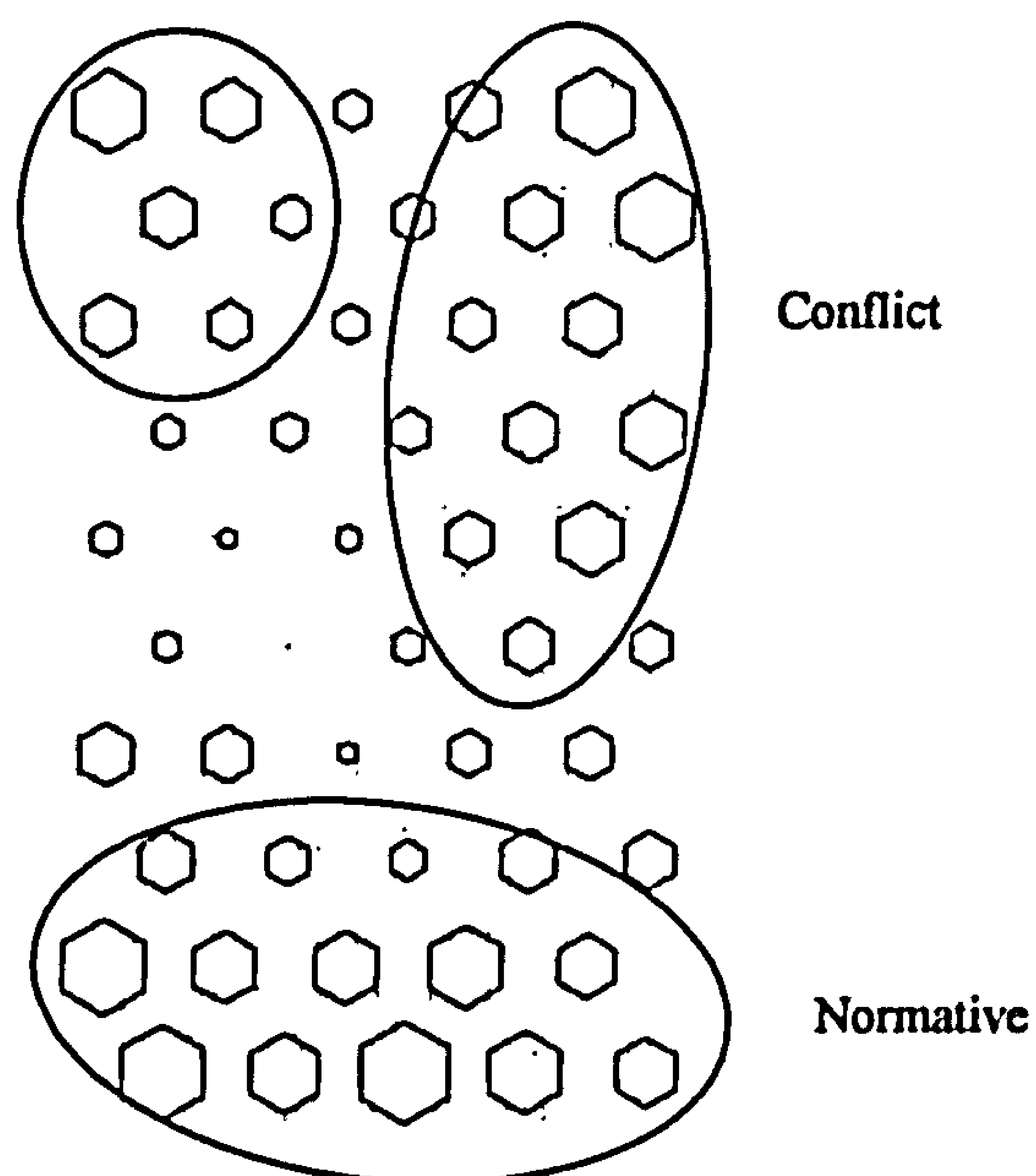


**Figure 6.45** Distance matrix or d-matrix (marker size) for 19th Century North America data (visually defined clusters circled)

**U-matrix and BMU**

The combined BMU's and u-matrix indicate three types of burial as in Figure 6.45, e.g. normative cluster, conflict cluster, and separate conflict cluster. In this map (Figure 6.46), the cases from the Custer site occupy the top left corner (coloured red). While these cases are similar to the other conflict cases in the upper portion of the map, they are clearly separated from the other conflict cases.

There are also a number of empty units in the centre of the map, suggesting these cases do not contain as many of the variables as their neighbouring cases. There are also a number of concentrations on the map indicating that some burials are very similar to each other. By identifying the BMU for each cluster, this pinpoints the case that represents the centre of each cluster. For example, in Figure 6.46, case 7, a burial from the Custer site (in the top left corner), by virtue of the size of the coloured hexagon, has a higher value than its immediate red neighbour. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space. Case 55 represents the unit with the highest value in the normative cluster.

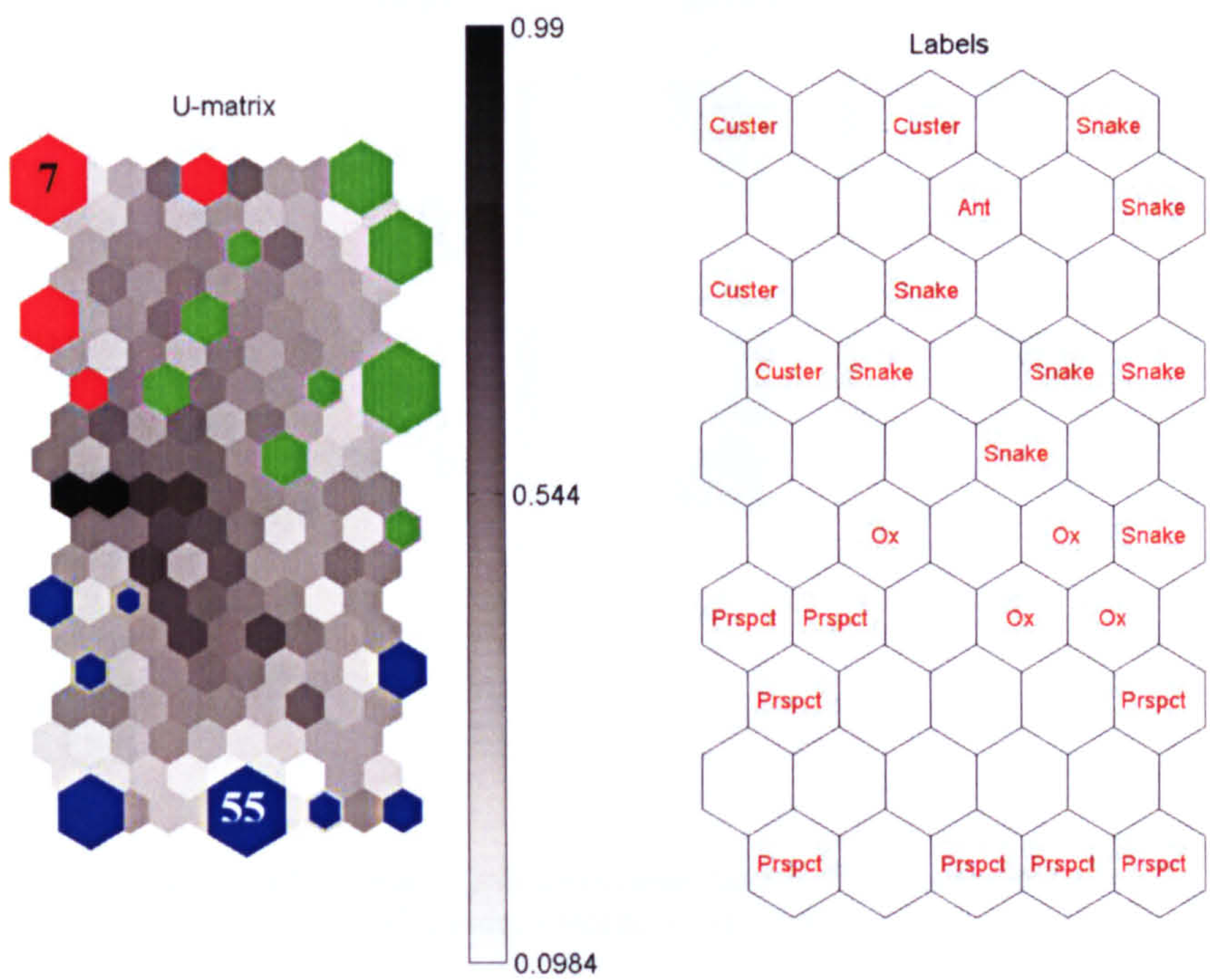


**Figure 6.46** U-matrix and corresponding labels and colour coded BMU's for 19th Cent. N. America data (Blue: Prospect Hill (Normative); Green: Antietam and Snake Hill; and Red: Custer)

### Component Planes

The component planes and the component plane reorganisation offered a visual representation to identify correlations between variables and the value (influence) of each variable in the overall map structure. Figure 6.47 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.48, the component planes are reorganised.

The shade of the variable GG (Grave Goods) in Figure 6.47 is very light, indicating a very low value - a maximum of 0.126 on the value bar. Its position in the right-hand side of the plane indicates that it does not correlate highly with other variables. Conversely, the variable CemTyp is very dark with over 80% of the plane having a value of 1. Considered together, these representations indicate a high number of individuals in a normative cemetery and a low number of grave goods in this particular dataset (see Appendix D.3.7 for abbreviations used to identify variables).

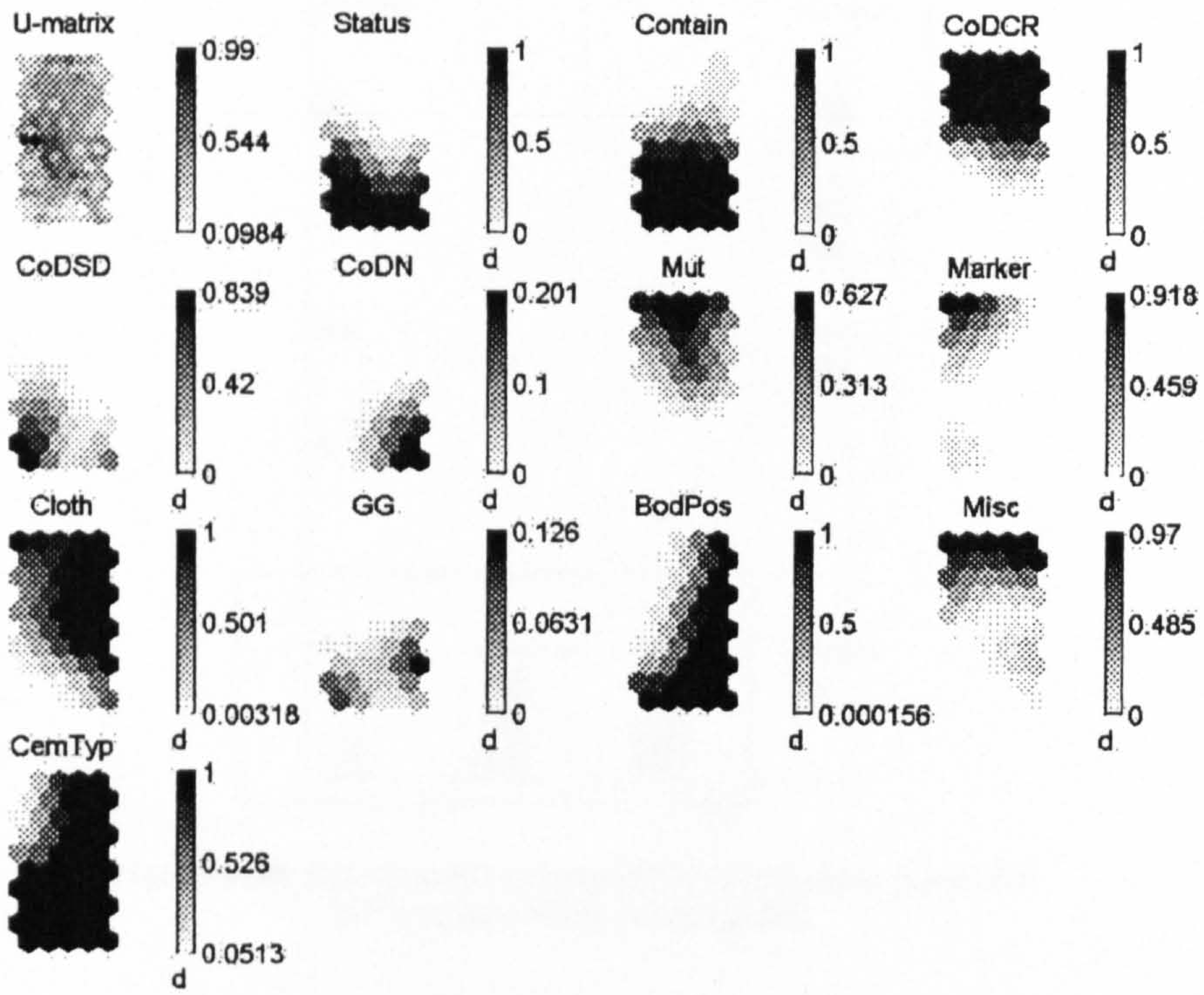


**Figure 6.47** U-matrix and component planes of all variables for 19th Century North America data

Additionally, the variables Misc. and GG are unlikely to be in the same burial as indicated by their shading patterns, which occupy opposite sides of their planes. The limited amount of overlap, suggests mutually exclusive behaviour. This pattern of identifying opposing patterns of behaviour extends to Status and CoD-CR, since civilians are not expected to take part in combat and maintain civilian status.

The other major use of the component planes visualisation is identifying correlations. The variables in Figure 6.48 form three groups. Normative characteristics are separated into two clusters. One normative variable cluster in the top of the map consists of Contain and Status (civilian), with CoD-N, BodPos, and CemTyp comprising the second group. While the variables CoD-CR, Misc., and Mut comprise another variable cluster. The similarity of component planes in each group indicates that the variables are well correlated. The spatial positioning of each variable is discussed below.

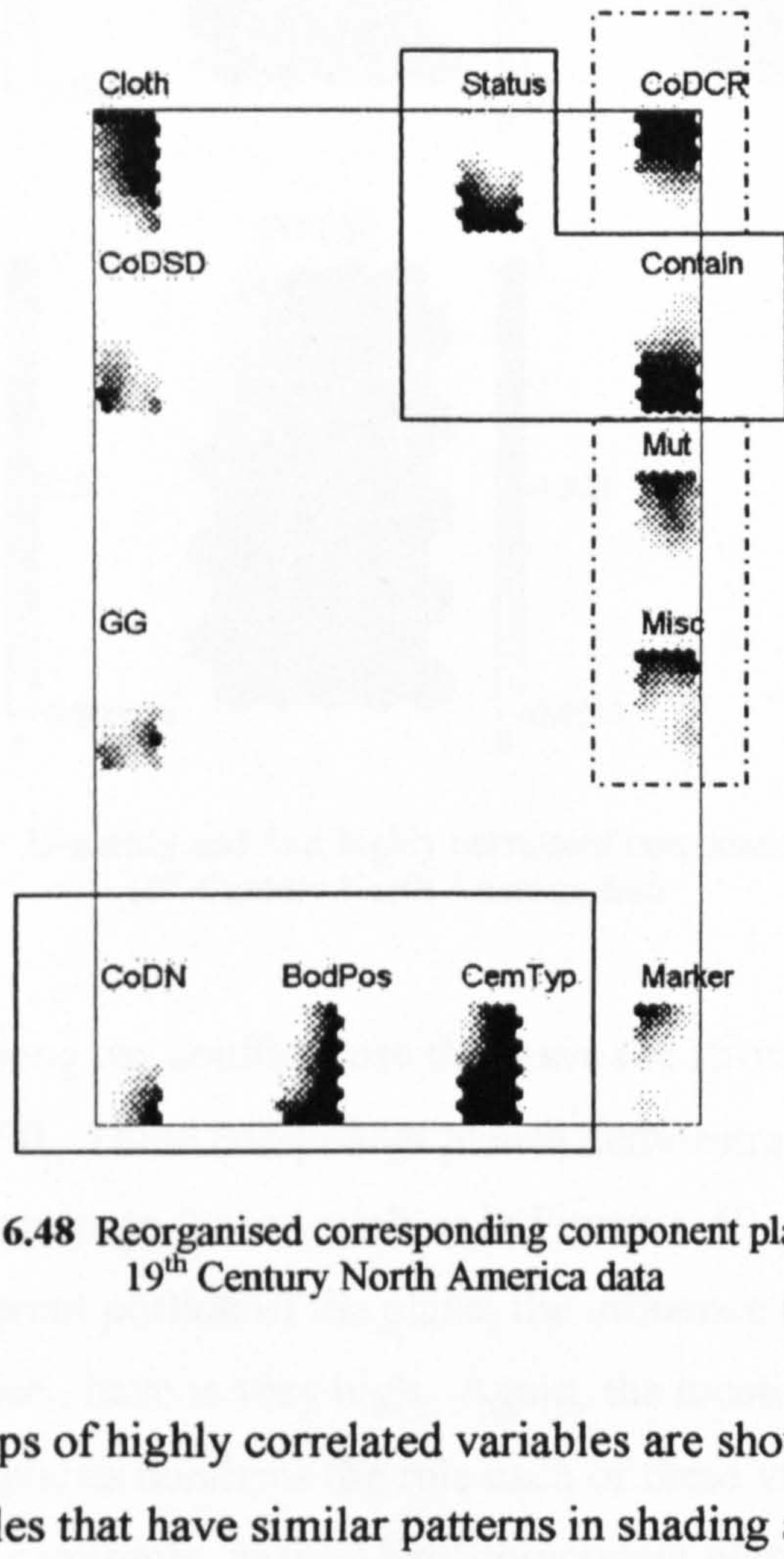


**Figure 6.48** Reorganised corresponding component planes for 19th Century North America data

Close-ups of two groups of highly correlated variables are shown in Figures 6.49 and 6.50. Four variables that have similar patterns in shading and values that correspond to behaviour in normative cases are shown in Figure 6.49. Note that the cases from the Prospect site (at the bottom of the plane) have high rates of normative cemetery and body position and the presence of container. In addition, the shading patterns and high values for each variable correspond to the location of the normative cases (as illustrated in the Status component plane labels). This correlation confirms that the normative burials that possess a container will be placed in a normative body position and located in a normative cemetery.

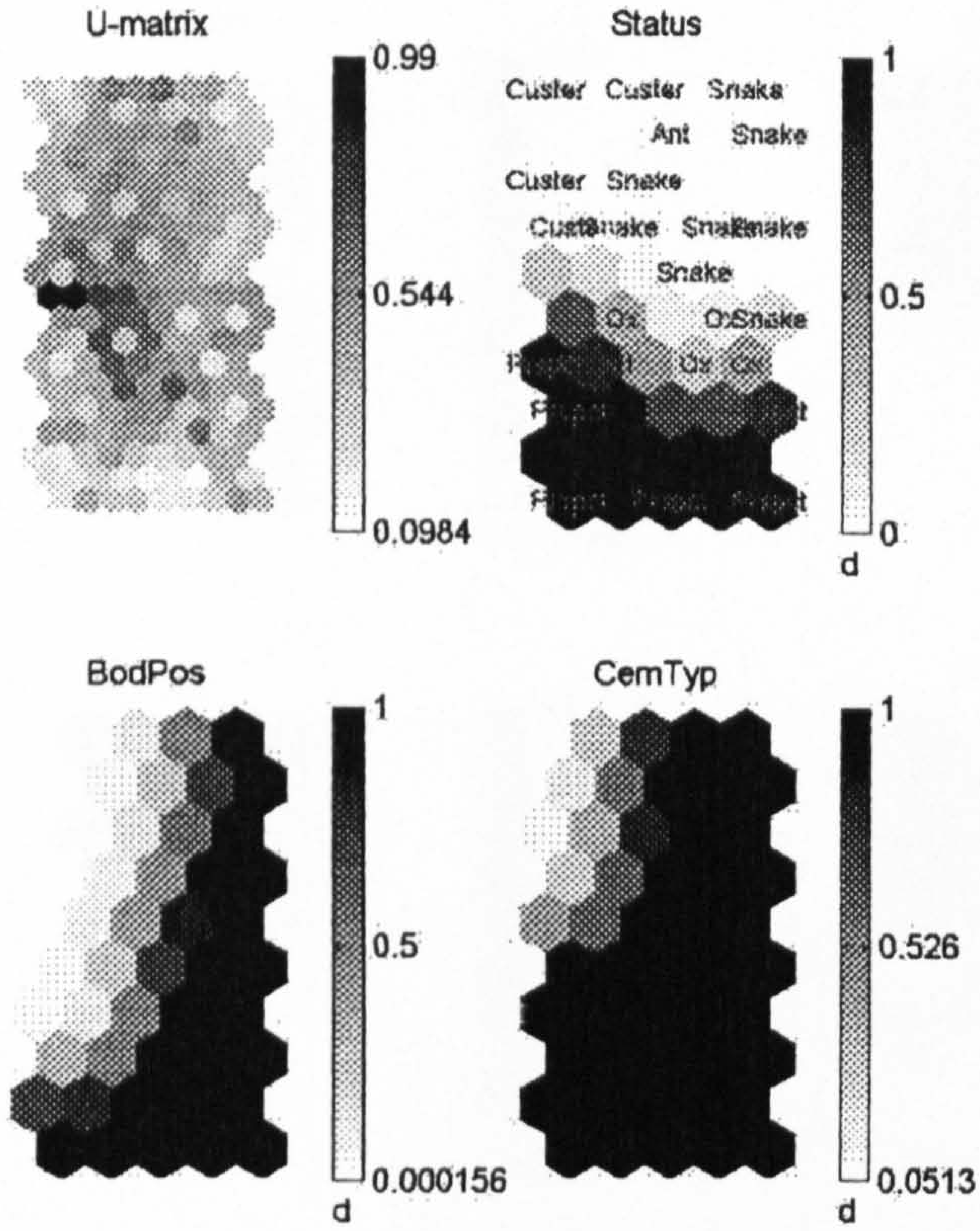


**Figure 6.49** U-matrix and four highly correlated component planes for 19th Century North America data

The three variables among the conflict case that have the strongest correlations are illustrated in Figure 6.50. These component planes demonstrate, by the patterns in shading, behaviour opposite to those variables in Figure 6.49. While that shading may be located in different portion of the plane, the influence these three variables, CoD-CR, Mut, and Misc., have is very high. Again, the location of the burials within the component planes confirms the role each of these variables has in how the data was clustered. For example, in the Misc. component plane in Figure 6.50, the normative cases are at the bottom of the plane where the value is zero, while the conflict cases are dispersed in the areas where the value is higher.

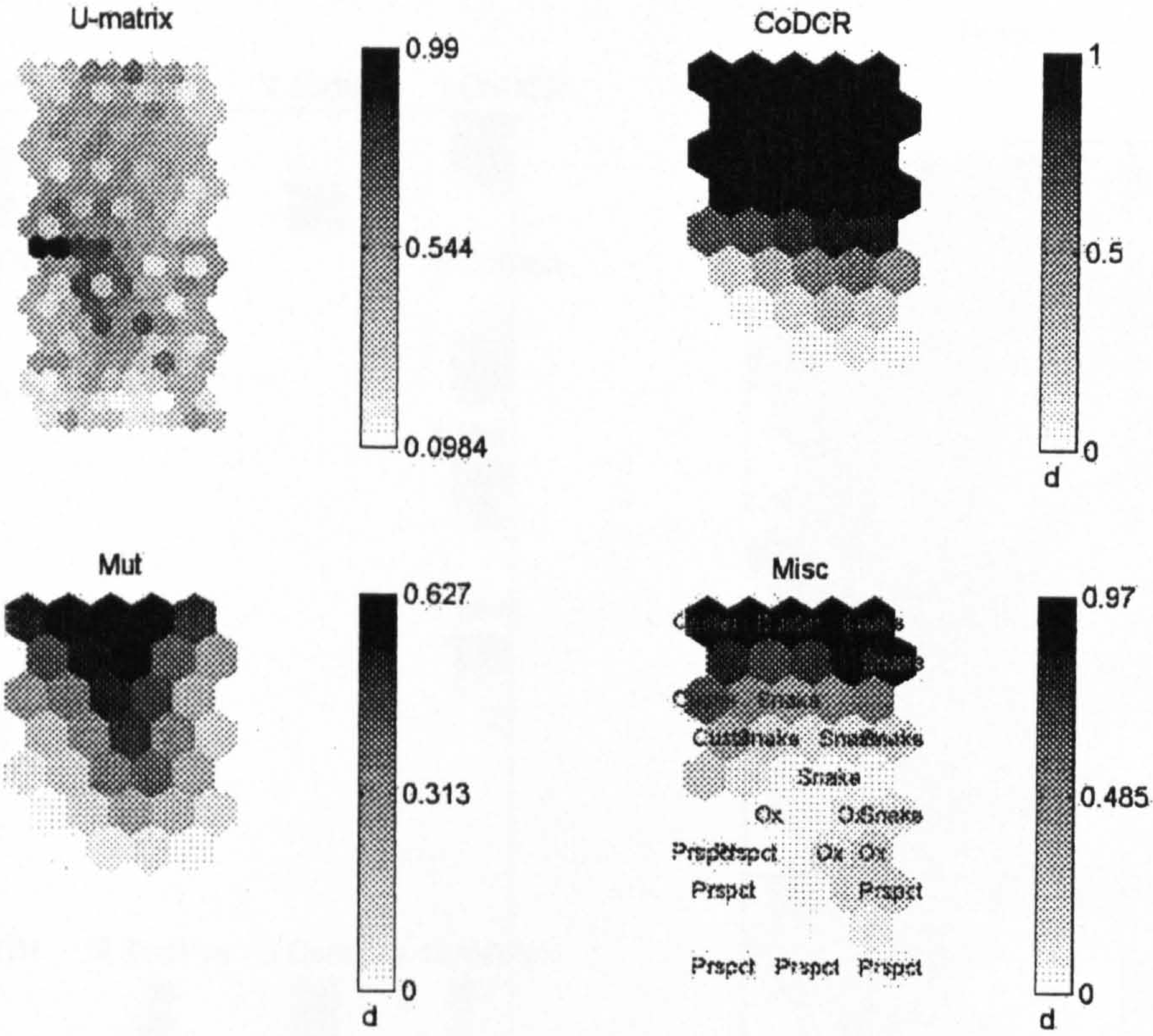


**Figure 6.50** U-matrix and three highly correlated component planes for 19th Century North America data

This placement suggests a strong correlation between these variables and the normative cases that are located in the bottom portion of the u-matrix (as labelled in Figure 6.44). This pattern in component plane placement suggests that these three variables Misc, Mut, and CoD-CR) would not be associated with the more normative variables in the lower part of the u-matrix.

The location of each of the 12 component planes (variables) on the overall u-matrix map relates to how the SOM clustered the cases based on possession of those variables. Consider the SOM examples in Figure 6.51: the component planes for Misc (miscellaneous artefacts) and Mut (mutilation) planes are at the centre of the map, indicating that the conflict burial cases they represent would have these attributes. Conversely, the component planes BodPos (body position), CemTyp (normative cemetery type), and CoD-N all occupy the lower part of the u-matrix.

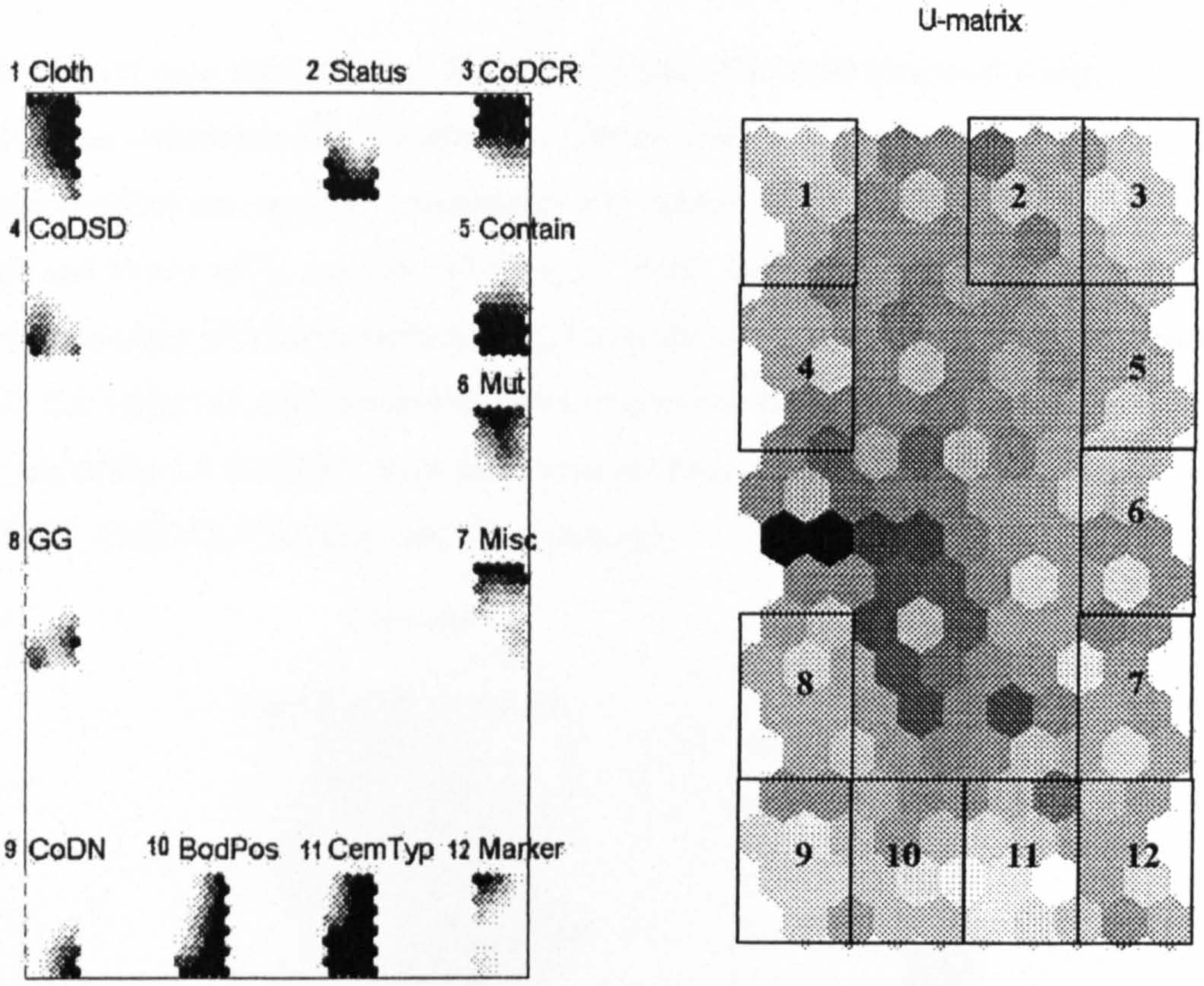


**Figure 6.51** U-matrix and corresponding component planes for 19th Century North America data

### 6.3.6.a Discussion

As indicated in Figure 6.44, one cluster corresponds to normative burials, two clusters represent two variations of friendly conflict burials, and a fourth (central) cluster consists of conflict friendly burials with large distances between map units on either side because there is a high degree of dissimilarity between this cluster and the surrounding clusters.

The SOM method using 12 of the 14 variables produced good differentiation of normative versus conflict burials and highlighted the degrees of variation among the friendly burials. Specifically, the SOM differentiated the higher degree of friendly burials (the Ox Hill cases) from the other burial types, based the presence of ritual markers (i.e. container and body positioning), hence, placement closer to the normative burials.

### 6.3.7 MEDIEVAL

The Medieval data used in the SOM are the same 73 burials analysed using multivariate techniques (see Chapter 5). The conflict data are 38 burials at the Towton conflict site, and the comparative normative data are 35 burials[9] from the church and Priory of St Andrew, Fishergate, York, which dates from the early to mid-15th century (for more information, see Chapter 3). There was little variation among the variables; this meant that fewer variables were used to test the burials. Only ten of the 14 variables were used because four variables had zero variance (CoD-SD, CoD-EJ, Clothing, and Obscuration).

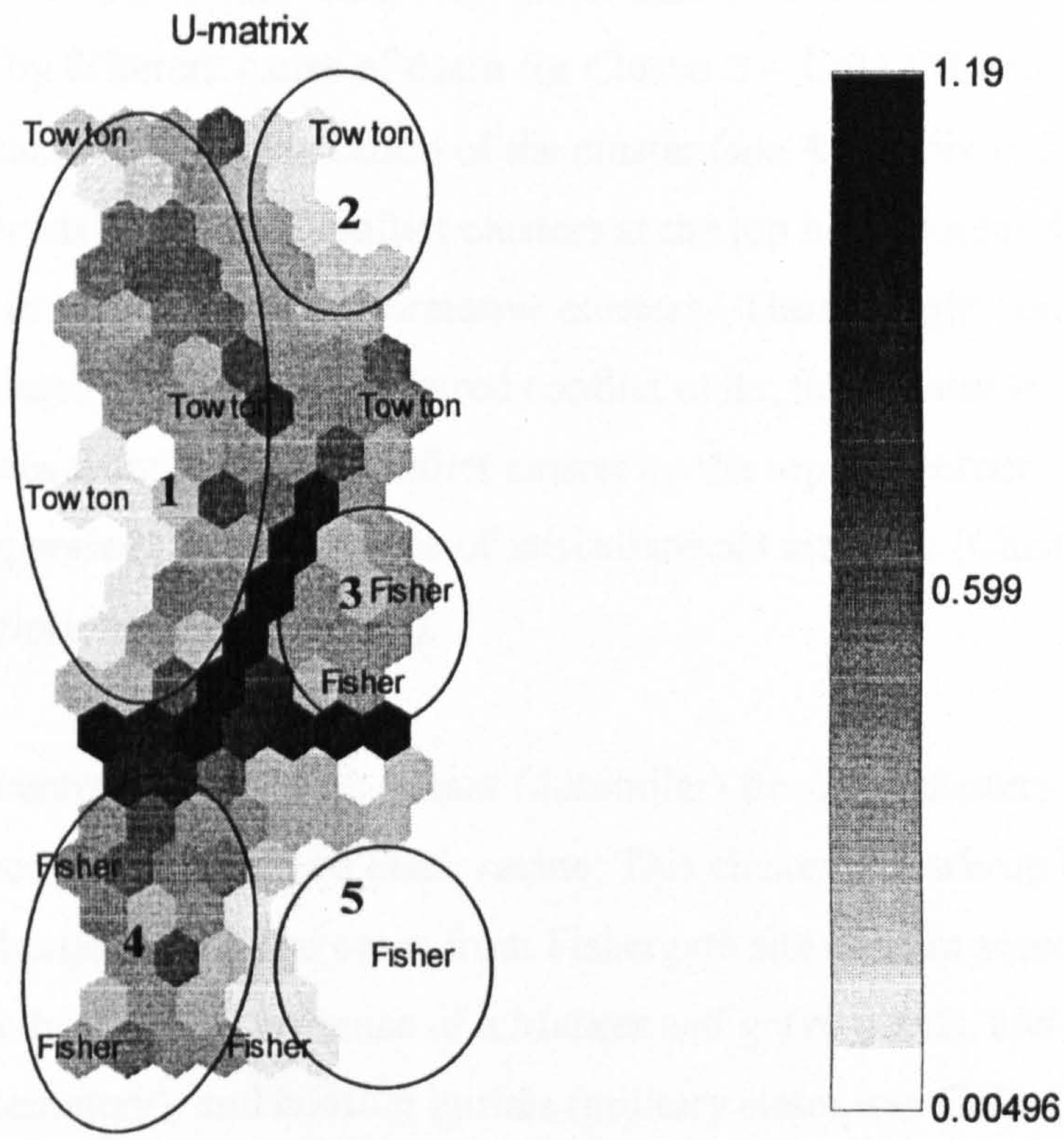


**Figure 6.52** U-matrix for Medieval data (visually defined clusters circled)

Two types of maps are created by the SOM from the Medieval data: u- and d-matrix clustering of the burial types (Figures 6.52 and 6.53); and the values of the component (variable) planes (Figures 6.55, 6.56, 6.57, and 6.58). The simplest of these maps define clusters based on the 10 variables. One additional map (Figure

[9] Abbreviations used as labels to identify sites
Towton Towton, Yorkshire, UK (Conflict)
Fisher Fishergate, Yorkshire, UK (Normative)

6.54), which included the location of BMU's, was created to provide more detail to the distinctions.

**U-matrix**

As in previous cases discussed above, the u-matrix (Figure 6.52) roughly separates the normative burials at the bottom of the map from the conflict burials at the top of the map, with a broadly scattered cluster in the centre. From the U-matrix, one can clearly distinguish several (five) separate areas. The normative clusters (Clusters 4 and 5) are uniformly shaded, representing a high degree of similarity between cases. Clusters 4 and 5 are closer to each other than either cluster is to Cluster 3. This distance is caused by different cause of death for Cluster 3 – CoD-CR and the status of the three cases that comprise the centre of the cluster (see Appendix H for individual case records). The two conflict clusters at the top have similar distance measures as those in two of the three normative clusters. The top right corner consists of a small area of very light coloured conflict units; this cluster is separated by some darker cases from the other conflict cluster on the top left corner. These two clusters are separated by the presence of miscellaneous artefacts (Cluster 2) (see Table 6.7 for descriptions of the clusters).

The cluster in the centre (Cluster 3) is distant (dissimilar) from the clusters on either side – as represented by the scattered black ravine. This cluster is made up of three cases from the Fishergate site. The cases from Fishergate site contain some aspects found in normative burials (i.e. presence of a Marker and grave goods, and a location within a cemetery), and conflict burials (military status and CoD-CR), which therefore places them along the border between both normative and conflict clusters, indicating distance from neighbouring cases.

The effectiveness of the u-matrix is seen here. While these three burials are in a normative cemetery, they occupy a distinct region on the map, which may be explained by the presence of "extensive blade injuries" (Stroud and Kemp 1993: 143) that suggest death during combat; therefore, it can be said that they are friendly conflict period burials, but from a normative dataset because a hostile party would not likely have access to a church for burial. It is the location of burial that suggests a friendly, or possibly neutral, rather than a hostile burial, which further reiterates the importance of examining the entire context of a burial to identify behaviour.

| Cluster | Burial Type | Variable(s) |
|---|---|---|
| 1 | Friendly | Military Status, CoD-CR, Mutilation |
| 2 | Friendly | Military Status, CoD-CR, Mutilation, Misc.Artefacts |
| 3 | Friendly | Military Status, CoD-CR, Mutilation, NormCemtery, |
| 4 | Norm | Civilian Status, CoD-N, GG, Body Position, Norm Cemetery |
| 5 | Norm | Civilian Status, CoD-N, Body Position, NormCemtery, Container |

**Table 6.7** Cluster assignment for Medieval Data. The cluster refers to areas marked on Figure 6.52

## D-matrix

The d-matrix (Figure 6.53) separates the normative burials from the conflict burials, with most cases belonging to either general burial type with some cases in the centre (along a diagonal axis), separating the two clusters (represented by the smaller markers). As with several of the d-matrices described above, this projection is clearer than the u-matrix in identifying two general burial types, but some of the more subtle variations are lost, such as the marked differences among the cases in the centre cluster (which are not as clearly defined here as in the u-matrix).

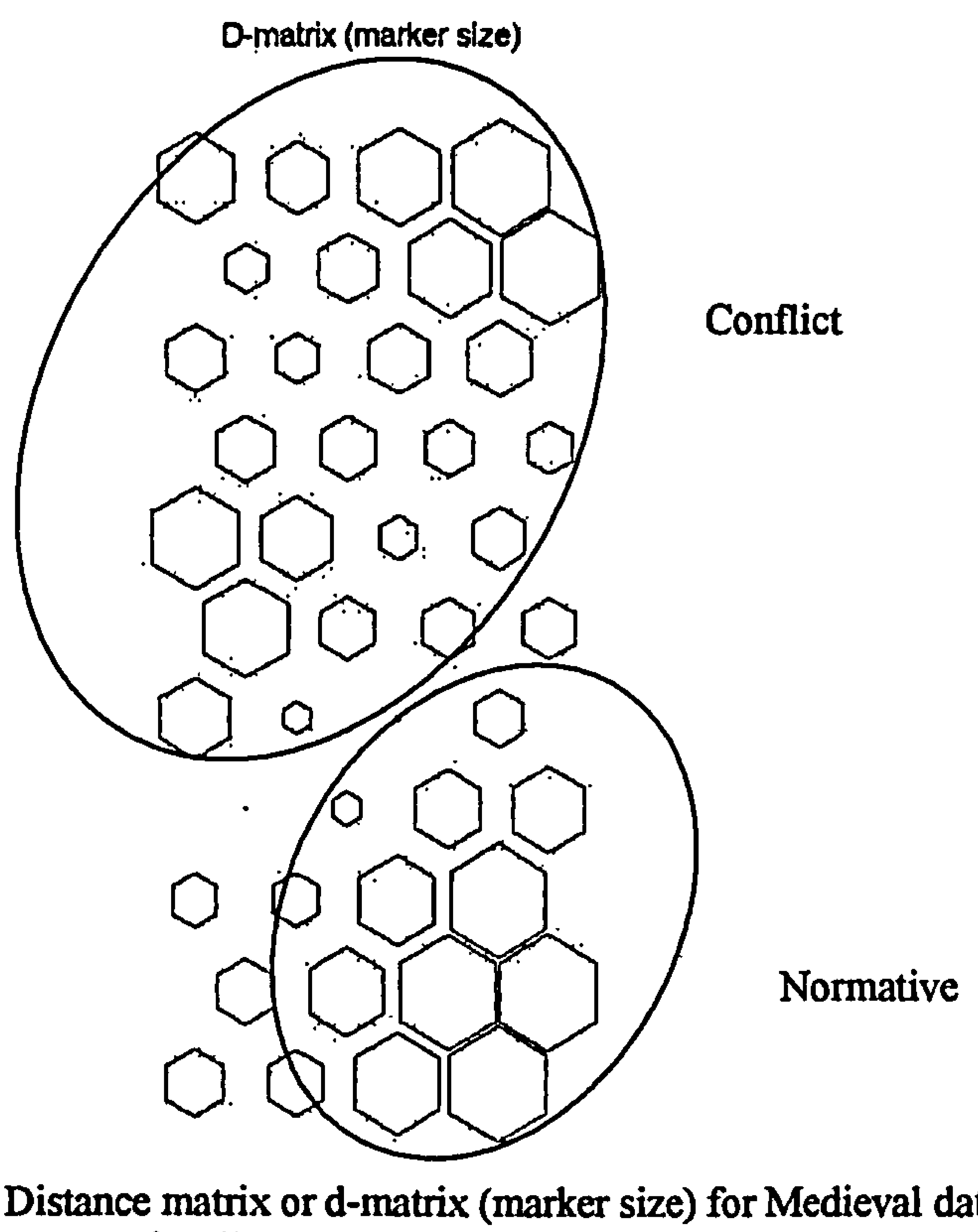


**Figure 6.53** Distance matrix or d-matrix (marker size) for Medieval data (visually defined clusters circled)

**U-matrix and BMU**

The combined u-matrix and the best matching unit (BMU) map indicated a division of the burials into the two types as indicated above, e.g. normative cluster and conflict cluster. In this map (Figure 6.54), cases 71, 72, and 73 are burials from the Fishergate site (identified by the black circle) – the same cases that comprise Cluster 3 in Figure 6.52. These cases suggest a possible increase in similarity between the two broader categories. Case 71, by virtue of the size of the coloured hexagon, has a higher value than its immediate green neighbour. This higher value means that more 'hits' occupy that map unit - the higher component plane values (the variable values) that make up that space.

In addition to identifying the BMU's for the map, the colour coding separates the different sites. The normative cases are green, while the conflict cases are red (Fishergate and Towton, respectively).

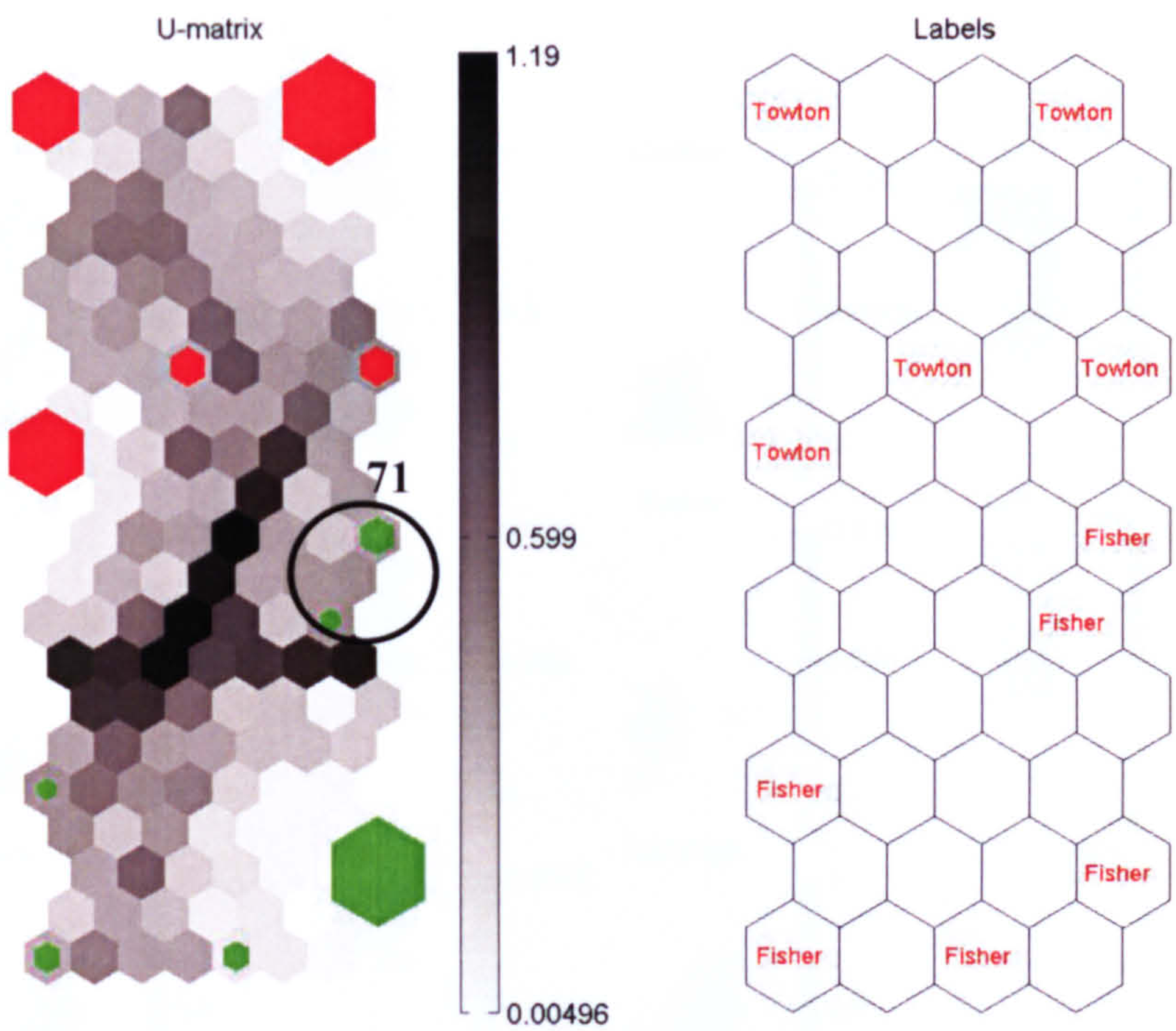


**Figure 6.54** U-matrix and corresponding labels and colour coded BMU's for Medieval data (Green: Fishergate (Normative) and Red: Towton (Conflict))

**Component Planes**

The component planes representation aided the search for correlations among variables. Figure 6.55 shows the component planes in the order in which they were entered in the test procedure, while in Figure 6.56, the component planes are reorganised. See Appendix D.3.7 for abbreviations used to identify variables.

In Figure 6.55 the shade of the variables Contain and CoD-N is very light, indicating very low values for these variables - a maximum of 0.181 on the value bar for both Contain and CoD-N (these two variables also had identical shading patterns). Their position in the bottom left hand corner of the plane indicates its correspondence with other variables sharing similar positions. Conversely, the variable BodPos is very dark with over 35% of the plane having a value of 1. Considered together, these representations indicate a high number of individuals in normative body positions and a low number of containers and/or natural cause of death in this particular dataset.

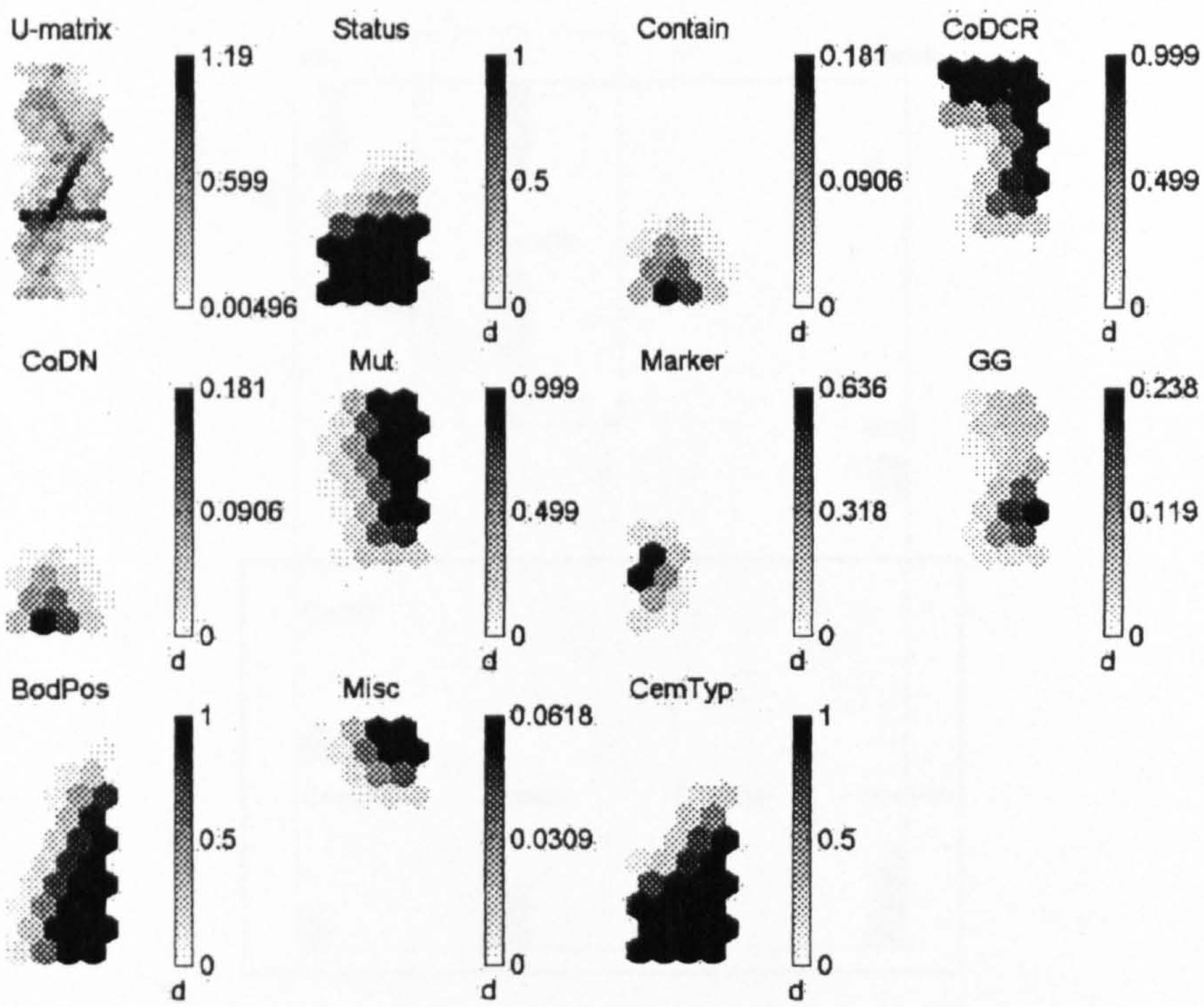


**Figure 6.55** U-matrix and component planes of all variables for Medieval data

Additional patterns in correlations are apparent. For example, the negative correlation between Contain and CoD-CR is evident in the opposing shading patterns. While the higher rate of value for CoD-CR is in the upper right-hand corner of its component plane, it is the lower left-hand corner of Contain that has the higher value. One thing to note is that conflict burial behaviours form consistent clusters in the map. The variables representing evidence of mutilation and a combat-related cause of death cluster together on the map as expected. The component planes also indicate strong correlations for Status, BodPos, and CemTyp, with a weaker correlation to container and CoD-N.

The other major use of the component planes visualisation is identifying correlations. The variables in Figure 6.56 form two main groups. Normative characteristics, Contain, CoD-N, BodPos, Status (civilian), and CemTyp comprise one group, while the variables CoD-CR and Mut comprise another variable cluster. The similarity of component planes in each group indicates that the variables are well correlated. The spatial positioning of each variable is discussed below.

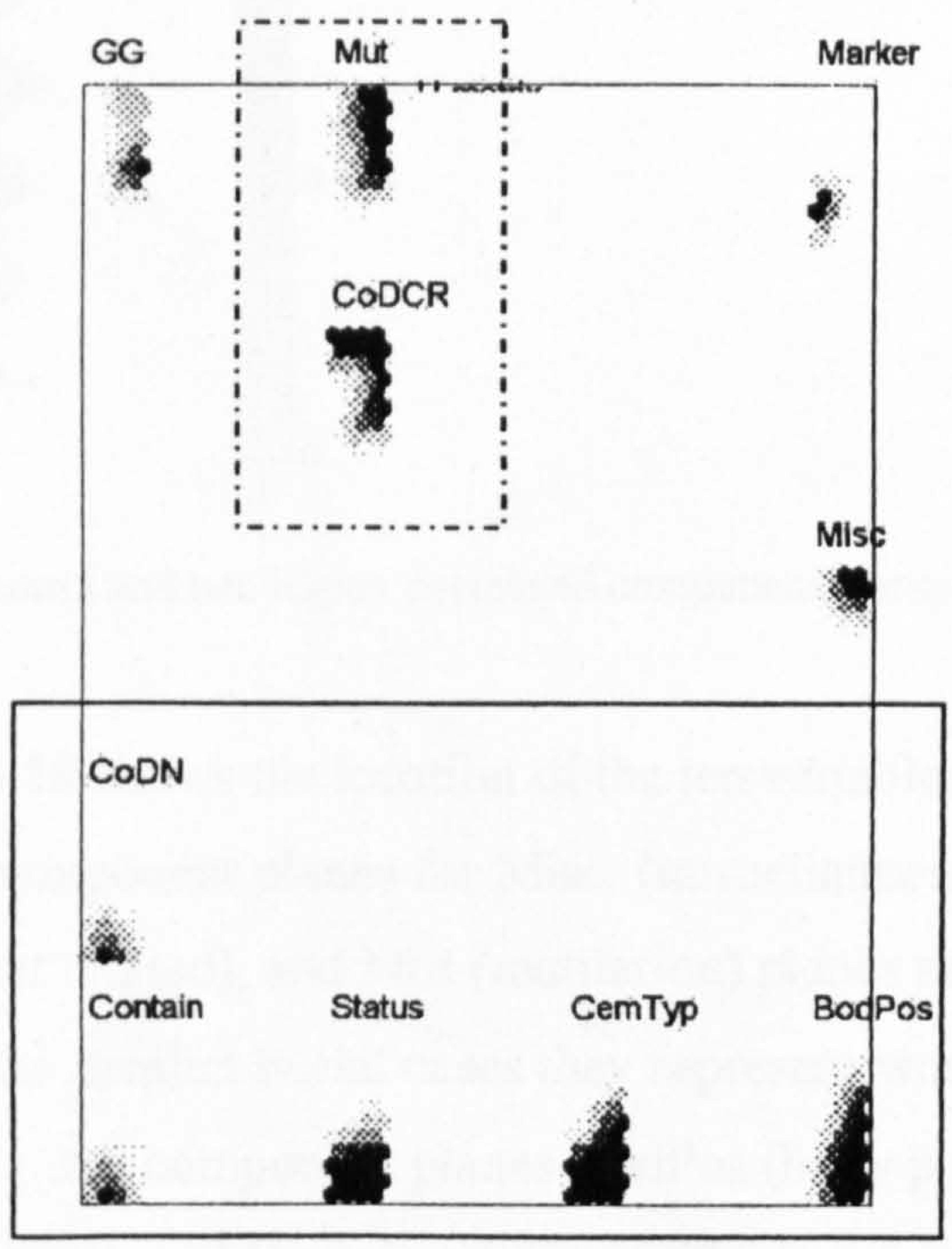


**Figure 6.56** Reorganised corresponding component planes for Medieval data

A close-up of the two highly correlated conflict variables is shown in Figure 6.57. Note that the cases from the Towton site and the three previously discussed cases from the Fishergate site have a high prevalence of mutilation and conversely, the normative cases do not. It is interesting to note that the patterns of the cause of death and mutilation have very similar shading patterns and almost identical values, thereby confirming that the burials with combat-related cause of death have a correspondingly high prevalence of extensive mutilation.

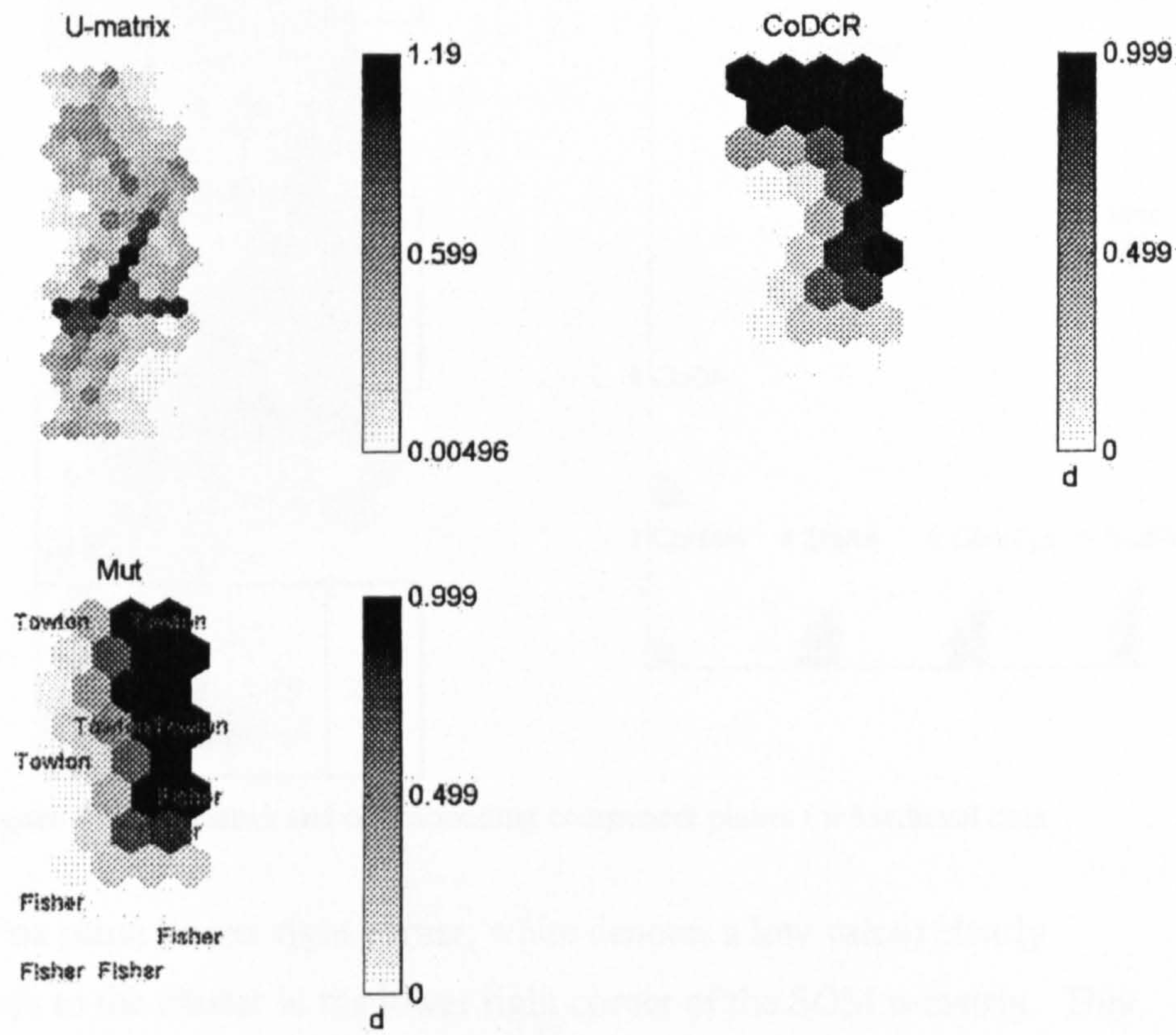


**Figure 6.57** U-matrix and two highly correlated component planes for Medieval data

The SOM in Figure 6.58 shows the location of the ten variables used to describe the Medieval data. The component planes for Misc. (miscellaneous artefacts), CoD-CR (cause of death-combat related), and Mut (mutilation) planes are at the top of the map, indicating that the conflict burial cases they represent would have these attributes. Conversely, the component planes BodPos (body position), CemTyp (normative cemetery type), and Contain all occupy the lower part of the u-matrix. This placement suggests a strong correlation between these variables and the normative cases that are located in the bottom portion of the u-matrix (as labelled in Figure 6.52). This pattern in component plane placement suggests that these three variables Misc., Mut, and CoD-CR) would not be associated with the more normative variables in the lower part of the u-matrix.

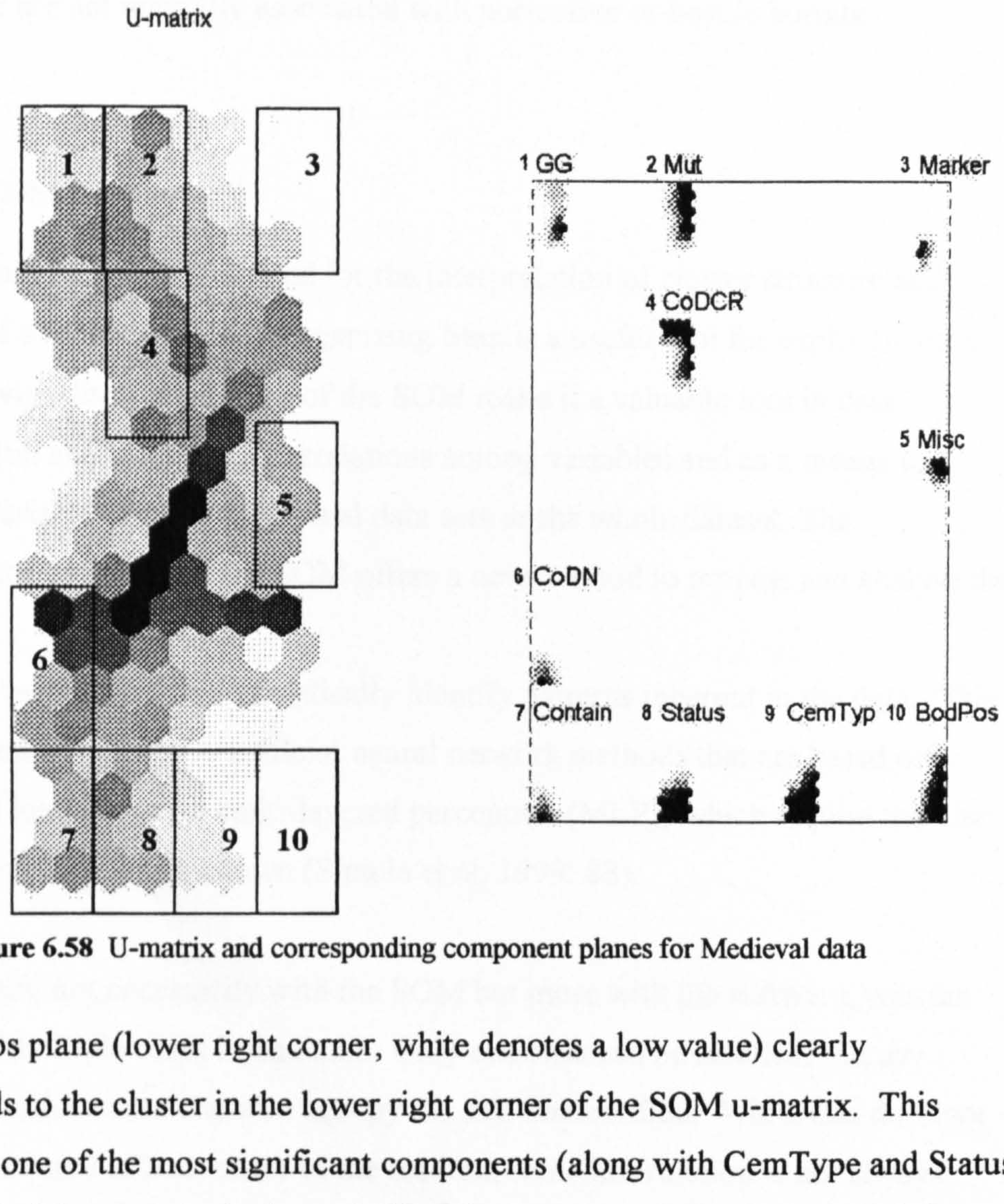


**Figure 6.58** U-matrix and corresponding component planes for Medieval data

The BodPos plane (lower right corner, white denotes a low value) clearly corresponds to the cluster in the lower right corner of the SOM u-matrix. This variable is one of the most significant components (along with CemType and Status) because all of the cases in the lower half of the map possess these characteristics.

### 6.3.7.a Discussion

As indicated in Figure 6.52, two clusters correspond to normative burials, two clusters represent friendly conflict burials, and a fifth (central) cluster consists of burials with large distances between map units on either side because there is a high degree of dissimilarity between this cluster and the surrounding clusters.

The SOM method using 10 of the 14 variables produced good differentiation of normative versus conflict burials. In addition, it identified the three Fishergate cases

(71, 72, and 73) as a separate cluster (Cluster 3). This cluster can be labelled as friendly conflict burials based on the presence of a combination of characteristics (i.e. military status, normative cemetery, mutilation, and combat related cause of death) that are not normally associated with normative or hostile burials.

## 6.4 DISCUSSION

A framework has been presented for the interpretation of cluster structure and contents of a SOM. The Self-Organizing Map is a useful tool for exploring data sets. The visualisation abilities of the SOM make it a valuable tool in data classification and identifying correlations among variables and as a means to compare variables among individual data sets or the whole dataset. The unsupervised approach of the SOM offers a new method to process and analyse data.

The SOM can be used to automatically identify patterns inherent in the data. This is an important advantage to artificial neural network methods that are based on supervised learning (e.g., multi-layered perceptron (MLP)) which require that the desired output values be known (Simula et al. 1999: 88).

One problem, not necessarily with the SOM but more with the software, was the location of multiple cases in one unit. Only one case can be labelled, thereby leaving the other cases that also occupy the unit unidentified. While this does not reduce the overall effectiveness of the method, some information is not always accessible.

The SOM was most successful at the intra-site (All Data) level with the three conflict burial types being identified as well as subtleties in normative burials. The method was able at all levels to identify and separate subtle differences in burial behaviour. In addition, the u-matrices illustrated the similarity between not only the clusters, but also individual cases. Furthermore, the structure of the map, with six immediate neighbours, shows the progression in more than one or two directions. It shows how that one case is related its neighbours and how those neighbours are related (by degree of similarity) to each other.

# CHAPTER 7 CONCLUSION

## 7.1 INTRODUCTION

The effects of conflict have several different physical manifestations. The burials studied here are not just remnants of conflict, but also representations of attitudes and behaviours of the living towards the dead, be it friend, enemy, or unknown victim. While battlefield archaeology focuses on the details of battles, forensic archaeology on the retrieval of remains, and a majority of mortuary studies analyse indictors of status and rank, the approach outlined here focuses more precisely on the actual burial process, involving the victim, those handling the body, and the material and spatial features of the subsequent burial. The goal is to explore the treatment of war dead across time, space, and culture by identifying characteristics of anomalous sites and behaviours at burial sites within conflict areas and suggesting possible explanations for those deviations from normative practice.

The archaeology of conflict burials therefore goes beyond the battlefield or traditional mortuary studies by examining situations in which humans, as social beings, faced with the burial of conflict casualties, must determine whether the interments will fall within the pattern of normal burial practices in their culture or not. To the extent that they exist outside the realm of familiar behaviour and attitudes, conflict burials have a potential to provide evidence of social processes related to attitudes about death and the dead, within and outside a cultural group. This 'conflict archaeology' is an amalgamation of archaeological techniques and forensic aspects that are applied to maximize information obtained from burial data. This approach incorporates current archaeological theories and methods because the burials are representations of cultural prescriptions for burial, filtered through the buriers' perception of themselves and others during conflict.

## 7.2 DEVELOPMENT OF A CONFLICT BURIAL MODEL

In order to recognise the patterns of behaviour manifested in conflict burials, it was necessary to develop and refine a theoretical framework to incorporate quantitative and qualitative analysis. A series of exploratory quantitative techniques, traditional multivariate analyses, and a neural networks process were applied to identify patterns in a diverse set of burial data. Unlike traditional studies that focus on single cemeteries or the mortuary traditions of a specific culture, this study selected diverse burials covering a wide variety of places, times and cultures as a means to test the suitability of the burial model for different circumstances. One of the more important features of the system applied here is that it can easily accept additional sites because all that is necessary is to code the data according to the parameters stated in Chapter 4 (within the limits of the existing variables) and added to the existing database. This flexibility not only allows for the inclusion of more data, but also the ability to increase, or decrease, the area of focus (e.g. individual site analysis versus intra-site analysis). Importantly, the model included qualitative data, which not only facilitated the detection of cultural traits, but also suggested the nature of the burial actions and attitudes, as represented in the material data.

As the appearance of conflict burials will vary according to the attitudes of those handling and burying the body, it was necessary to study the normative burial rituals of the combatants. The context and appearance of a normative burial, one that follows the religious conventions of a society, provides a standard of comparison for the identification of anomalies that may indicate variations in body treatment in conflict burials. What is symbolised in burial must be viewed with consideration of the social dimensions, which are of the highest symbolic importance because individual statuses can be intentionally or unintentionally disguised, especially in a conflict-related context.

The quantitative methods were applied within the framework of a model developed to describe the characteristics of three different types of burial carried out by three different types of individuals: compatriots (friendly), neutral parties, or enemies (hostile). The identification of these groups was based on a collection of variables concerned with the treatment of the body and the attributes of the grave, such as grave furniture, grave goods, markers and artefacts associated with the grave fill. It was necessary to include variables representing all these aspects of burials because conflict burials have a complexity that other mortuary practices do not – they are carried out during times when normal rules of behaviour do not always apply.

The 14 variables used were determined by the lowest common denominator of information that was present in all the datasets. Despite the initial problem with a sufficient level of data for model definition, what was developed is a coherent model that does depict the actions and behaviours present in these conflict burials within the focus of body treatment and general categories of artefacts. While there is some overlap of characteristics between friendly and neutral, and neutral and hostile, the three burial types are independent from one another and can be recognised in the data.

The first model describes the expected characteristics of a grave by friendly groups during conflict periods, the second describes what is expected in a grave prepared by a neutral group, and the third describes hostile burials. The normative burials of the region or culture provide a means of comparison. The variables used to define the burials are the cause of death, presence or absence of ritual markers, and body treatments. These patterns of behaviour are applicable to all models and are represented in some form in all data. It is through these treatments that clues to the events that occurred and who was responsible for burial can be ascertained. However, none of these variables will offer much to the interpretation of the behaviour at these sites unless there is reference to the context of the site, since the interpretation of a burial extends beyond the gravesite and into the culture.

The model defines very basic features of death and burial in a conflict setting. Given that in times of conflict, ordinary cultural behaviours and customs may not always apply, the differentiation of burials was complicated by some of the potential variants that cut across the boundaries of friendly, neutral, and hostile attitudes. For example, an individual who was executed could be buried by friendly or neutral groups (Cyprus 1974), or an individual who died as a result of illness could be buried by a hostile group, as occurred in Korea. Consequently, this thesis considered the totality of the behaviours and actions at burial sites in order to interpret what took place, as it is the entire burial context – not simply the body – that provides the necessary evidence. The model in fact allows more than just the documentation of individual remains in specific contexts; it enables the identification of patterns in body treatment that can be applied to conflict burials in general. In the analyses described here, it had varying degrees of success, depending on what level of variability was present at each site and the quantitative method used. Most importantly, the information yielded by the analysis in each case showed patterns in the actions of those handling the bodies, as indicated by the specific patterning of the variables, which allowed for at least a hypothetical identification of their relationship to the deceased.

As with human behaviour, the definition of a model and the characteristics of the three burial types are dynamic. Since burial behaviour is not limited to one set of features, neither is this model. The model can be modified or refined to incorporate different levels of data and/or focus. Furthermore, the model is not bound to any one method of analysis or quantitative technique. This point is made clear when examining the results of the quantitative methods.

One important issue to note is that the database was used to define and test the model. The testing was limited in this way because it was extremely difficult to get appropriate data to even develop a model, let alone test it independently. The problems were partly what motivated this research in the first place. While conflict is or has been a feature of all cultures, the detailed study of conflict situations and events has been much more limited. As a result, conflict burial excavations are either conducted without appropriate excavation and recording techniques or, as in the case of virtually all modern research on conflicts, unpublished and inaccessible, due to legal restrictions or disinterest on the part of the agencies and individuals involved in the work. Consequently, there was not sufficient real-world data available, which included different burial types and different behaviours within those burial types, to introduce a new dataset to test the model further. This goal is one for a future regional investigation of a conflict 'battlescape' using traditional archaeological survey methods and the assistance of historical documents and, most importantly, local and regional authorities.

For the purposes of this thesis, however, the limitation is not a significant problem, as it moved the analysis to an equally important set of problems about the applicability of a burial model to data from what is much more typical in the archaeological record: scatters of small sites from different conflicts among people of different cultures and religions across the centuries. Furthermore, the model was developed in a way that makes it possible to test it when sufficient, higher quality data is available, as it was *intended* to be modified and adapted.

## 7.3 Results and Comparison of Multivariate Techniques and Neural Networks

The quantitative analyses that were applied here relied heavily on a contextual theoretical framework and model. It is important to note that multivariate techniques were used to identify potential groupings in data, while the SOM became the process used for interpretation. The quantitative methods were applied with two goals in mind: 1) process and explore the data, isolate patterns and relationships, and identify which attributes most clearly defined the model's burial types; and 2) identify a quantitative method that complements the model with the most successful rates of burial type recognition.

The data were tested in three basic samples: All Data; All Conflict data; and site data composed of conflict and normative data representing an area of study (for example, all Spanish data tested as one site). Three types of traditional clustering methods and one neural network method were used for each of the three samples for testing.

Agglomerative hierarchical clustering was used to test both the cases, and the factor scores that were derived for the cases. Factor analysis was used to examine correlations between variables within the dataset as a whole, within conflict only data, and at the individual site level. In addition, factor analysis was applied as a validation method in order to evaluate the clustering results. The third multivariate technique used was k-means clustering. It was applied to act as an alternative to hierarchical clustering results because not only does it use a different approach to the data (*a priori* assumptions on the structure of the resulting clusters), but it analyses the data with a different method of measurement than that used in the hierarchical clustering. The neural network analysis consisted of one method, the Self-Organizing Map. This technique is an unsupervised non-linear mathematical approach that can identify clusters as well as correlations in the data.

**Discussion and Evaluation**

The results indicated that information could be extracted with the three multivariate methods applied (factor analysis, hierarchical clustering, and k-means clustering) across the different datasets. The combined use of these methods is considered here to be useful because it helps to identify the advantages and disadvantages of each method, as well as which techniques are not useful.

Hierarchical cluster analysis had variable results across the datasets, ranging from good to poor, but the relative ease of use, and its history of use in archaeology make the application of this technique to burial data an acceptable approach. This is not to say that there were not problems with the system. The skewed results because of a single instance of ritual marker or body treatment affected the overall results for some applications, while hierarchical clustering of factor scores was especially susceptible to the influence of outliers.

At the site level, the hierarchical clustering had good predictive power for identifying normative versus conflict burials, and at the inter-site level, the clustering clearly separated military versus civilian status. In addition, k-means clustering, which was used because that method tests hypotheses and produces the number of clusters designed by the model, produced similar results to hierarchical clustering, though at times based on the effect of different variables. However, since the conflict period neutral burials are quite similar to both friendly and hostile burials, the k-means performed poorly in differentiating neutral burials from the other burial types when they are present (e.g. Korea and Bosnia); as such, it created an additional cluster even though it was not based on the characteristics of neutral burials, but based on the variation in cause of death. In addition, in the k-means clusters, classification was initially based on the variation in cause of death at the expense of the other variables and their impact on the context of the burial.

At the level of testing all conflict data, the statistical analysis did not offer any more information than that produced at the site level. Overall, the results suggest that there is little variation in the type of burial contexts across region, period, or conflict type. This general lack of differentiation indicates that there is a high level of similarity in the mode of disposal during conflict periods, especially burials under similar conditions (e.g. those buried behind the front line are quite similar over time). For example, those buried at Snake Hill (from the War of 1812) are quite similar to the individuals buried at Ox Hill (from the American Civil War, 1862). However, one should proceed with caution and not attempt to speculate on relationships between populations and the type of conflict that produced the burials. The burials from the Balkans dataset provide a good example on how characteristics traditionally attributed to one type of burial, neutral during battle (e.g. military paraphernalia, military status) are combined with the characteristics of another type of burial (e.g. civilians, cause of death-extra judicial (CoD-EJ)), a hostile burial. When analysing such a diverse dataset, it is important to recognise the variations in cultures, symbolic meaning, and conflict.

The clustering of factor scores at all levels and for all datasets performed poorly. It did not provide a clear illustration of the data because the factor scores for the cases do not accurately represent the data. As a result, the clustering of factor scores not only did not produce useful results, but also showed what can happen when an inappropriate method is applied. Manly (1994: 134) discourages the use of principal components scores and factor scores in this manner because of this issue of factor scores not representing the data. In addition, this is a controversial method because the relationships between clusters may be blurred because of the assumption that the factor scores are normally distributed (Aldenderfer and Blashfield 1984: 21). While factor analysis proved to be a useful tool in the reduction of variables and identified relationships between variables, the results of clustering individual case factor scores were less successful. This poor predictive power of factor analysis in case identification may be because of the presence of outliers in the datasets. Outliers appear to have influenced the final factor score, hence the heavily skewed results of clustering the factor scores. As a result, the clustering of factor scores illustrates a weakness in the application of the method to this data.

Overall, the results of the statistical tests were successful at a very basic level (clustering based on either normative or conflict characterisations); however, at the finer level of clustering the model's three conflict types, the multivariate techniques results were not as convincing, especially when there was a mixture of identifying behaviour markers present. These results therefore raised the issue of the appropriateness of the linear methods used to analyse this complex dataset, because the behaviours that produced the characteristic features of each burial and burial site were cultural aspects that are non-linear in nature or discern subtle human behaviours that are a part of everyday human activity. Despite these issues, traditional quantitative methods can identify the variables that have the strongest impact on analysis as well as identify relationships between variables or sets of variables.

Despite the measured success of the multivariate results, there remains room for improvement of the analytical techniques used here. Further tests involving completely different burials from different regions and time could help to better evaluate and develop the multivariate methodology used here. This would allow a refinement and development of what was, in some situations, a helpful method of investigation; however, multivariate techniques do not work easily with data that may represent changing attitudes and situations. Furthermore, it was intended that the results from the statistical analysis would complement a qualitative approach, and in some instances instigate new avenues of study, but not replace a qualitative assessment of conflict period burials.

Moreover, the multivariate methods cannot respond to situational change. There are all types of variables that are not culturally considered or planned during conflict. Adherence to the normative pattern may be altered due to the pressure of time, lack of suitable equipment, or even the burier's knowledge of the appropriate rituals. Some of these variables are attitudinal – something that cannot be measured by multivariate statistics. There is therefore a need for a method which can respond to the unpredictability that is present in conflict situations.

The solution in this thesis was to use neural networks, which allowed for the analysis of both quantitative and qualitative data to indicate patterns and to group similar cases together. Neural networks analysis offers a visual, non-linear methodology for analysing complex, non-linear mortuary data. The method incorporates an unsupervised competitive method that defines cluster membership but does not make assumptions about the distribution of the data. Furthermore, the SOM incorporates correlation analysis and clustering in one method, reducing the number of applications to be performed. An additional appealing feature was that the results are presented as images, such as the main SOM cluster structure and component (variable) correlations.

The SOM method, at all levels of analysis, identified normative versus conflict burials. The SOM separated quite clearly friendly conflict from hostile conflict burials as well as identifying the neutral burials. The method also clustered burials on degrees of friendly behaviour. The SOM even identified subtle variations in the normative data when different cultures were represented by separating those cases from the other normative cases. Furthermore, the SOM isolated cases that did not follow a consistent pattern of characteristics of either friendly or hostile burials, but contained different combinations of the variables as well as singling out cases that have attributes of both general types of burial.

Overall, the results of the SOM in clustering the data based on the four distinct burial types (normative, friendly, neutral, and hostile) were generally encouraging. The SOM was not only able to separate burial types at a broad level (normative versus conflict), but also identified subtle variations within these two broad categories. Additionally, examination of the component planes suggests significant patterns among variables within the three different levels of data analysis. Similar to the results of the multivariate analysis, the status variable had strong correlations to all the causes of death at the site level and at the inter-site level. Examination of the component planes here indicated a number of significant patterns among variables at the three different levels of data analysis, similar to the results from factor analysis. One notable difference between the SOM and factor analysis correlation results is that with the SOM, not only is the correlation between variables evident, but also its influence (based on its value) on the cases (as illustrated by the variables location on the u-matrix) and the overall clustering pattern is evident and easier to identify.
At the site level, the SOM was quite successful in identifying normative versus conflict burials, and at the inter-site level, the clustering clearly separated six patterns of burial behaviour. The SOM identified three variations in conflict burials (separating friendly from hostile) and three variations among normative burials. In addition, the SOM, because of its visual nature, was able to display the results in a way that makes subtle differences within larger burial types appear. For example,

the Balkans data was clustered into two broad burial types (normative and conflict), but within the larger normative cluster, there is a sub-cluster consisting of the normative Bosniak burials, which differ from either Serbian or Croatian normative burials, hence the distance.

The SOM was especially successful at the intra-site (All Data) level in identifying friendly and hostile burials, as well as differentiating cases that can be labelled as neutral based on the burial characteristics. Conversely, it was at this level that the traditional multivariate techniques performance was least successful in clustering the different types of burials. The SOM results for the Conflict Only data were also quite successful at clustering cases according to burier/dead relationship. The clusters that were formed correspond to the characteristics as defined by the burial model, such as the presence of ritual markers among the friendly burials (primarily the 19$^{th}$ century North American sites) as well as a large number of miscellaneous artefacts present in the hostile cases from the Balkans and Spanish sites.

The results suggest that all of the variables influenced the SOM results simultaneously, unlike a dominant variable in the more traditional multivariate techniques. The clustering of the Korea data demonstrates this different method of approaching variables. A majority of the cases in this dataset were hostile burials; however, there were a statistically small number of cases that had different causes of death or ritual markers. The SOM results identified a series of burials that are different from those hostile cases and the normative burials; thus suggesting neutral burials in this case, whereas the multivariate methods placed them into a larger, broadly defined conflict cluster.

The Spanish results indicate a clear separation of hostile from friendly from normative burials whereas the 19$^{th}$ century North America data results produced degrees of friendly behaviour in the burials. Many of the cases from Snake Hill and Ox Hill were in close proximity to the normative burials. The prevalence of ritual markers and body treatments attributed to this clustering behaviour. The Medieval data possessed a minimal amount of behaviour (e.g. grave goods, markers, miscellaneous artefacts), either due to taphonomic processes or by design or circumstances. This absence in the conflict burials suggests a neutral burial, or marginally, a friendly burial. The self-organizing map method was able to distinguish this behaviour from hostile, normative, and clearer examples of friendly burials, while the multivariate techniques were unable to clearly identify this variation in burial behaviour.

Another example of the effectiveness of the SOM was demonstrated in the clusters derived from the Medieval data. Three burials from the Fishergate site occupied a distinct region on the map, thus creating a cluster of anomalous burials within a majority of normative cases that is clearly separate from both conflict and normative burials, thus indicating unique behaviour among the normative burials.

Despite the differences in conflict type, culture, and period, the results suggest that there are few differences in the burials present. Again, this lack of variation suggests that there are similar disposal behaviours during conflict periods. The use of the SOM method provided insight to the dimensions of the datasets. It was able to produce a finer resolution of the data and to extract some of the more specific variations in behaviour, such as the subtleties of normative burials in the Balkans.

The SOM produced better results than those of the traditional multivariate techniques because it was able to classify burials beyond the broad normative versus conflict category, and identify two of the three burial types defined in the conflict burial model at the inter- and intra-site level. The SOM was not only able to separate burial types at a broad level (normative versus conflict), but also identified subtle variations within these two broad categories. The non-linear algorithms were able to distinguish some of the more subtle human behaviours that the traditional multivariate techniques could not. Furthermore, it provided a good platform for identifying and analysing correlations among variables and which variables that had the strongest impact on the data.

While the traditional multivariate methods did identify the general normative and conflict burials, the SOM proved to be a much better method in identifying patterns in mortuary behaviour during conflicts as well as identifying the three burial types defined by the conflict burial model. However, the model and the methods were not always able to identify burial type as indicated by the results from the SOM when cases were very distant from, and not members of, clusters.

To reiterate, the two statistical clustering techniques (when analysing the data and not factor scores) correctly separated normative and conflict burials correctly. However, the differentiation between the conflict burial types was not as successful. At the All Data level none of the multivariate methods applied were able to differentiate conflict burials. When testing only conflict data, the results were similar with large clusters around zero distance being identified in all sites based on an individual's status (civilian or military). At the site level, conflict burial identification was better. The most successful application of the multivariate methods was the hierarchical clustering of the Spain data. It identified the three friendly burials from the other hostile and normative burials.

At all levels of testing, the clusters that emerged from the hierarchical and k-means clustering were primarily based on status, and secondly on cause of death. As a result, this placed an unintended structure on the data because deviations from that general pattern either skewed the data so dramatically that separate clusters were created for one or two cases, or their uniqueness was completely overshadowed by the majority of cases, such as the neutral burials in the Korea dataset.

The Self-Organizing Map did not base the clustering on one or two variables, but on all the variables to various degrees as well as indicating the level of influence. For example, at the All Conflict data level the clustering was influenced, but not entirely segregated, by the presence of ritual markers (i.e. grave markers, grave goods, and miscellaneous artefacts not normally associated with burials). This process of influence rather than hierarchical structuring allows the cluster definition not to be limited to strict boundaries, and indicates the level of similarity between cases and other clusters. Consequently, cases that do not fit a cluster do not skew the overall results, nor are they misplaced in the process of cluster definition.

The success of the results, using the combination of traditional multivariate statistics and neural networks within the parameters of a detailed burial model, suggests that continued refinement of the whole analytical approach to conflict burials will produce clearer results in the future. It cannot be stressed enough that the survey, recording, and analysis of conflict battlegrounds, or regional 'battlescapes', need to be improved beyond the retrieval of bodies and artefacts that identify them. Combining the methods presented here – with continual refinement of the approach – along with historical research and documentation, should provide more detailed understandings of the culture or cultures of conflict, wherever they may be.

**Modifications to the Methodology**

The use of some of the methods listed above has helped demonstrate how different contexts may emerge in analysis, and how certain factors are detected or which burial types predominate. In addition, the analysis also indicated which steps or methods are unnecessary. For example, the k-means clustering method step is not only limited by *a priori* assumptions made on the data and the resulting structure, but also the clustering is dominated by one variable. This unduly diminishes the value and influence of the other variables in the clustering process. Furthermore, an additional multivariate clustering method was redundant since the results from k-means were also very similar to the results of the agglomerative hierarchical clustering.

A second step that can be removed from the multivariate analysis is the clustering of factor scores. The clusters that were created did not even remotely resemble the general trends and patterns in behaviour that were present in the data. This method was heavily influenced by the presence of outliers, thereby rendering the results useless beyond the identification and isolation of outlying cases.

The limitations outlined above indicate that the only multivariate techniques that are suitable for use with the conflict burial model are: factor analysis for variable reduction and identifying correlations among variables; and hierarchical clustering for classifying cases.

While the SOM worked extremely well in processing and representing the data, one important problem with the analysis of the resulting SOM illustrations is the clarity of cluster division. When clusters are very close to each other, they may not be identified as individual clusters, but as a single, larger cluster, as was the case with the identification of sub-clusters at the site level in several instances. This problem is particularly apparent in the d-matrix display; however, careful examination, and a multiple displays strategy, can help keep this effect to a minimum.

One feature of the SOM that is not necessary when there are a small number of variables is the component plane reorganisation step. The maximum of 14 variables used at any one time here proved to be too small a number to warrant the reorganisation because examination of the original layout was sufficient to identify correlations among variables based on shading patterns. However, in studies of a significant number of variables (for example 40 in Vesanto and Ahola 1999), component plane reorganisation has shown itself to be a useful tool.

In the end, the SOM is able to produce better results not only in classifying cases, but also identifying correlations than the three multivariate methods; furthermore, the SOM was able to do the analyses of two different multivariate techniques in just one method. It is quite reasonable to suggest that well-defined attribute clusters defined by the parameters of the model can be easily identified using the SOM if the data used are sufficiently detailed and precise. The neural network had the advantage of non-linearity to analyse non-linear mortuary behaviour. While the SOM proved to be a good method in identifying different burial types from the available, properly excavated and recorded burial data could use all the advantages of the SOM.

The methods used in this thesis were applied to provide information that is interesting and useful in identifying patterns of mortuary behaviour during conflict as well as providing the groundwork for future applications of the SOM in archaeology. Such tools can help to construct a methodology to analyse complex data beyond the limits of more traditional methods and approaches to mortuary studies, however, it is important to take the analysis further, as tools alone are not enough to place the results in a cultural or historical context.

The following question was asked in Chapter 4: Is there a cross-cultural standard of burial during conflict that can be identified? Likewise, is the burial type an expression of the social persona, not that of the dead as proposed by Saxe (1970), but that of the individual or group doing the burying? The results of this thesis suggest that there is a minimum standard of behaviours in burials according to type (friendly, neutral, or hostile) evident cross-culturally, regardless of what century the burial took place, or the type of conflict within a greater contextual approach. As expected, friendly burials were the easiest to identify, such as those at the Snake Hill site where the friendly burials followed to varying degrees the parameters of the friendly burial model. Since there is a recognisable standard for conflict burials, it can be said that the identity of the burier is inherent in the identification of the type of burial, and can be recognised as such. Therefore, it is the social persona of the burier that is represented in the burial, sometimes conflicting with the normative expression of the persona of the dead.

## 7.4 FUTURE WORK

The methodology applied here, more specifically the Self-Organizing Map, enabled the analysis of multiple scales in space and time. It is not site specific, or level specific, limited to a particular place or time period, or focused on internecine or international conflicts. It is a methodology that can be applied to various regions, various conflicts, and in different time periods, from prehistoric to more recent events. There are cases from the Napoleonic Wars to the present that, if excavated and recorded to the degree of detail outlined in this thesis, would be ideal tests as to the applicability and effectiveness of the proposed model and methodology for identifying those responsible for burial.

As was noted in the discussion and evaluation of results above, it was difficult to find data with sufficient unrestricted information; this accounts for the specific problems examined and the range of dates and conflict types used in this analysis. However, the implication of the results for future research in general is that it may significantly increase the potential in each of these cases for an analysis and interpretation that goes far beyond the descriptive results so far published. For example, a refinement of the Snake Hill data from the War of 1812 is possible. The original model could be modified to examine siege warfare and its affects on soldiers confined to a fort with dwindling supplies. The model could identify the progress of the siege by determining to what extent the burials, which are friendly, conform to normative practices. If the lack of provisions and physical weakness of the survivors, and the psychological stresses under which they are living, causing a breakdown in morale, it may be apparent in burial behaviour. If this is the case, the analysis of burial may show variation in the norm. This is an example of the different kinds of problems that the model can be re-developed to analyse.

The method and approach have proven to be successful in classifying types of burial behaviour from conflict, including identifying degrees of friendly burial behaviour, such as a minimal degree of friendly burial behaviour which includes a normal body position but without grave goods, marker, or container from the data from the Korean War. There are hundreds of cases of individuals from the conflicts in Korea and Vietnam that can be examined. Used in conjunction with information regarding troop movements and battle lines, the approach could prove useful in examining a large dataset from the region. For example, by identifying friendly and hostile burials in a spatial context, set against information regarding troop movements and battle lines, might provide more insight into the actual events that took place on the battlefield.

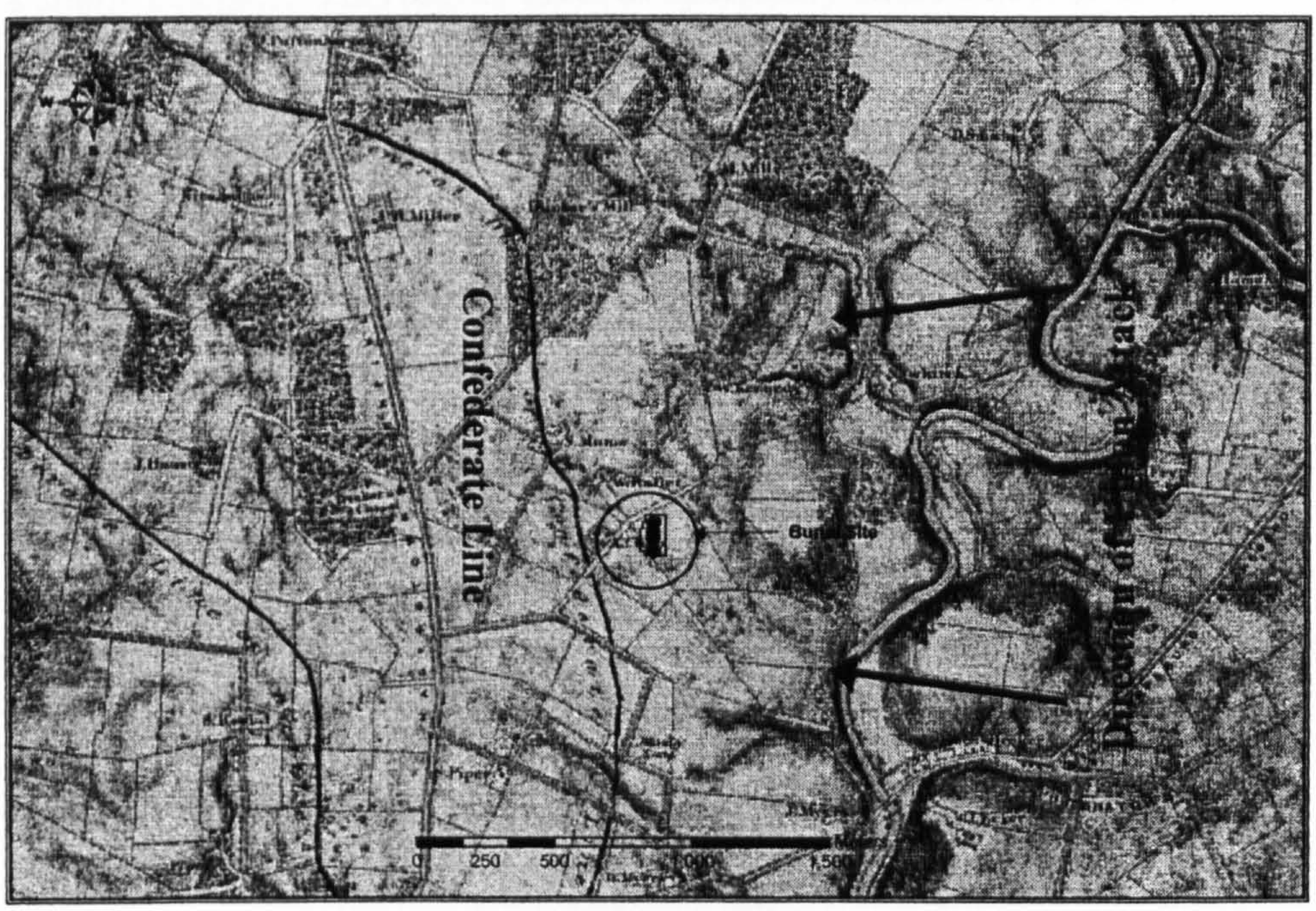


**Figure 7.1** Location of Antietam burial site and battle lines, September 1862, Sharpsburg, Maryland, USA (Michler 1867)

For example, Figure 7.1 shows the battle lines during the battle of Antietam, September 1862 and the location of the burials used in this study. The map shows where the burial is in reference to the Confederate lines, and the direction the Union forces attacked. The location within the limits of the Union attack supports the conclusion that these are Union soldiers in friendly burials that occurred after the battle.

This example shows how the results from the analysis can help determine whether these soldiers were killed on the battle line and then buried back of it (friendly type burial) or buried by the enemy after the battle line was broken (hostile type burial) – this would help chart out the ebbs and flows of battle. More generally, this methodology creates new types of potential applications for effective analysis of burials in a context-aware arena by using a contextual approach.

In addition to the identification of circumstances and events at burial sites, analysis at the inter-site level may aid in the process of predicting where other mass graves may be located, given the spatial and temporal patterning of a conflict.

The model may be refined to accommodate more specific artefact detail if the study is of a single conflict. This higher level of specificity could uncover more information about the circumstances of death as well as offering a higher probability of correct burial type identification. This has promise in the analysis of remains that have been uncovered along the Western Front (1914-1918). More can be learned, and in more detail, about the events of battles and troop movements, which can then be compared to the historical record. What is most crucial in any of these future analyses is, as this thesis presents, a contextual approach to the excavation of burials. In all cases, the model needs to be modified to represent the period and cultural context presumed to be present in the burial. For example, variables used to define a 15$^{th}$ century Plains site in the United States would not include armaments; as such, the variables, and the entries for those variables, need to be updated to represent that situation.

Future studies can use the methodology outlined in Chapter 4 to focus on different attributes and populations, such as focusing on sex and/or age composition, whether significant patterns emerge with regards to more specific causes of death, or individual artefacts, rather than the general presence or absence applied here. The system can also be used in a 'reverse' identification process. The variables defining age, sex, ritual markers, and miscellaneous artefacts can be used to estimate the cause of death if it is unidentifiable (non-skeletal trace) or unknown. This process could be applied in a situation where more specific cause of death information is unknown, yet other contextual indicators are present, such as in a prehistoric setting.

An ideal application of the methodology would be to locate and examine the mass graves of over 20,000 Soviet soldiers belonging to a Ukrainian division that was destroyed by 2,000 Finnish troops along the Raate road in Suomussalmi, Finland during the Winter War (1939-1940). The aim would be to identify a battlescape through a structured research design that would: 1) identify known battle sites to locate areas with a high potential for conflict burials; 2) survey the material evidence and documents, and examine previous work and known excavations in the area; 3) investigate and excavate; followed by 4) the application of the model in two stages (if enough data has been recovered in order to split the dataset into two parts), one to refine the model, and the second to test the applicability of the model and its results.

The analysis of a site such as this can indicate not only the identity of those responsible for burial and the prevailing attitudes toward the dead, but also the conditions under which burial took place, and possibly the amount of time that took place between death and burial. Further examination could be done in the more traditional realm of battlefield archaeology as well, such as examining the course of the battle, the combat methods used, and how individuals were equipped. It may also be possible to determine whether the type of conflict or the time within an individual battle or war might be identified from the burials and burial behaviours. This would not only identify such forgotten dead, but also contribute to constructing a cultural landscape that goes beyond death and burial to the consideration of the wider conflict and society.

One important point to make is that the better the recording done in the field, the more avenues of study the burial will offer. This issue is particularly relevant to cases where the retrieval of remains takes precedent. The problem is that the remains retrieval technique, with its narrow focus on only remains, cannot provide information about the broader society and events, which may be crucial to understanding what happened and who took part. The model developed here, if adapted as a research design, will improve data gathering techniques, which at present, do not provide sufficient detail to develop a context of behaviour.

As a result, the material evidence is not always recognised as significant and the optimal recovery of skeletal material and artefacts suffers as well as the theoretical aspect of archaeology. On the other hand, if future studies use the approach outlined here, they will not be limited to general body treatments and general artefact types, which can only provide descriptive information, but can explore more specific actions and behaviour that can assist in the development of social and historical interpretations.

Ideally, burials from a specific conflict would be excavated in a comprehensive way, exploiting the burial context that will not only expose the remains, but expose the event. Alternatively, a compilation of burial records, as done to a degree in this research, can be applied (presuming the data are of good quality). This is followed by processing the data with the model and interpreting the results by working with historic documents and other records of the conflict, as well as incorporating spatial analysis (GIS), to correlate the results by locating the friendly, neutral, and hostile actions against what is known in descriptions of the conflict.

Most importantly, future studies need to include analyses of burials in the context of not only culture, but also conflict, and how behaviours change during such situations. Only then can an accurate depiction of conflict burial behaviour emerge – a goal towards which this research is the first step.

## 7.5 CONCLUSION

Traditional methods of investigating conflict burials are lacking because they focus on the retrieval of the body often at the expense of evidence of cultural behaviour. The goal of this thesis has been to put this right by refining methods of excavation, analysis, and interpretation and making the approach more consistent with archaeological methods and theories.

The model proposed in section 2.4 identified three basic burial types, and the variables used to define those burial types, in graves resulting from conflict situations. These are termed Friendly, Neutral, and Hostile burials. Through the examination of the conflict situation and patterns of body treatments, burial location, and associated artefacts, these different burial types can reveal who was ultimately responsible for burial and the prevailing attitude toward the dead. This allows for statements to be made about the people who buried the dead and their relationship to not only burial, but possibly the role of the burier in the cause of death.

The results suggest that there is a pattern of burial in conflict situations that has remained quite consistent for centuries, be it a friendly or hostile burial within a certain degree of situational variation. There are similarities that span conflicts in body positioning and associated artefacts, which supports the idea that attitudes to friend and foe are manifested at burial sites. Importantly, the model and methods extracted patterns and relationships between the dead and the burier that were already inherent in the data. It is important to note that these patterns in burial behaviour are not 'rules' in the Binfordian sense, but patterns that emerge from individual contexts of conflict and burial.

The research has also presented a set of features to look for in future analyses of conflict burials. For example, the physical attributes, such as grave location, the type of grave construction, articulation of the body, forensic indicators, and the presence or absence of ritual markers need to be noted for analysis. It may be possible to use the model to determine if a burial relates to a conflict or not when examining forgotten burials in places that have seen conflicts in the past. Many cultural landscapes have an enormous amount of unwritten histories of conflicts, wars, and battles.

The methodology and theoretical framework proposed here focus on a new central figure in mortuary analysis, not the dead, but the burier. It also examines their role in not only how the dead are interred, but also their relationship to the dead under the socially disruptive conditions of conflict. Indeed, conflict creates a culture of its own. It is not a matter of soldiers and their battles; conflict, or even the fear of conflict, transforms whole societies, as they must respond in often unexpected ways to the tensions and destruction of war and the social, political, and economic problems that result. It is therefore the particular features of the cultures of conflict, attitudes and actions directed towards the living and the dead, that are present at least in part in the archaeological record described here, and available on the landscapes of conflict across the world. There is a wealth of information in conflict burials that remains unexamined, as this thesis shows, and the promise that a new perspective will increase their value in the study of the most traumatic periods in the life of a society.

While it might be assumed that the emotional or psychological aspects of conflict behaviour are beyond archaeology, especially when quantitative methods are used, the approach presented here applied a non-linear process, neural networks (e.g. SOM), supported by multivariate statistical methods, that was able to distinguish patterns in that burial behaviour. These patterns would not have been identified without a sound body of theory and properly constructed models to define what to actually look for in the data. The systematic examination of the attributes of an individual's death and the treatment of their body, as preserved in burials, reveals patterns of cultural behaviour that provide greater insights into the complex actions and events that make up conflict situations.

Nicholas Saunders in his study of the Western Front described the landscape as "inert – an empty backdrop to military action", and the Front itself as "a prime example of the social construction of landscape, of landscape as [an] ongoing process" (Saunders 2001: 37). By resolving the circumstances of burial, as this thesis and its analytical model attempt to do, it may be possible to redefine the traditional landscapes of death represented in traditional historical accounts.

The use of a formal burial model with a combination of multivariate statistical analysis, and most significantly, neural networks, advances the study of mortuary archaeology in two ways: 1) it provides a specifically designed approach to conflicts that takes into account the variability in death and burial circumstances – a flexibility that more traditional approaches lack; and 2) it provides a structured set of variables to inform and improve excavation and recording techniques, which are too often focused simply on the retrieval of remains.

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## APPENDIX A – ORIGINAL DATA FOR KOREA DATASET[1]

*(Used with permission from the Joint POW/MIA Accounting Command Central Identification Laboratory)*

| Burial | Location | Grid Coordinates | MNI | Burial Dimensions |
|---|---|---|---|---|
| A | 1 | 52S BV 49677/19353 | 1 | 1.5 x .40 x .40 m |
| B | 2 | 52S DH 02754/40357 | 1 | 2.5 x 1.1 x .85 m |
| F | 4 | 51S YE 45322/24135 | 1 | 1 x 1 m x .20 m |
| G | 4 | 52S BK 50329/17516 | 2 | 1.1 x .50 x .40 m |
| H | 4 | 51S YE 45664/24420 | 1 | 2 m dia x .60m depth |
| K | 6 | 51S YE 36227/27745 | 1 | 2 m x 80 x .30 m |
| P | 10 | UNKNOWN | 1 | 4 x 4x 1 m |
| S | 13 | 52S CT 599 400 | 1 | 3.5 ft deep |
| T | 6 | 51S YE 280 390 | 1 | 2.5 x 3 m x .40-.80m |
| V | 15 | 51S YE 55356 22057 | 2 | 3 x 2 x 1 m |
| W | 16 | YE 4228 2545 | 10 | 1 x 2 m x .50 m |
| X | 4 | 52S BK 4525/2015 | 1 | 1 x 1.7 x .65-.75m |
| Y | 4 | 52S BK 5498/1725 | 2 | .35 x .70 x .25 m |
| Z | 4 | 51S YE 4850/2470 (a) | 1 | 1 x 1.7 x .90 m |
| AA | 4 | 51S YE 4855/2460 (b) | 4 | 1.05 x 1.45 m |
| BB | 4 | 51S YE 4861/2465 (c) | 1 | .75 x 1.1 m |
| DD | 4 | 51S YE 4761/2620 | 1 | One 2x2 unit, two 2x4 units, three 4x4 units, one 2x6 unit m |
| EE | 4 | 51S YE 5080/2305 | 2 | 1.1 x 1.4 x .40-.60 m |
| FF | 4 | 51S YE 4991 2717 | 1 | .65 x .25 x .25 m |
| GG | 6 | 52S BK 5680 2160 | 3 | 4 x 4 m |
| HH | 17 | 52S BK 5680 2153 | 1 | 4 x 4 m |
| II | 17 | 52S BK 4440 1605 | 3 | .55 x .30 x.40 m |
| JJ | 18 | 51S YD 5066 9095 | 3 | 2.63 x 1.0 x .48 m |
| KK | 19 | 51S YD 5335 8670 | 1 | .90 x .50 x .58 m |
| LL | 19 | 51S YD 5335 8670 | 1 | 1.17 x .54 x .64 m |
| MM | 4 | 52S BK 5410/1712 | 3 | 1.80 E/W x .80 N/S x 1.20 m |
| NN | 19 | 51S YD 5585 9620 | 2 | 1.5 x 2 m x .50 m |
| OO | 19 | 52S BJ 4328 9643 | 2 | .75 x .5 m x .75 m |
| RR | 6 | 51S YE 3710 2771 | 2 | 2.4m E/W x 1m wide |
| SS | 21 | 52S CK 5470 8250 | 12 | 5.5 x 1.0 x 1.2 m |

[1] Unlike the other data used in this research, the original Korea data is not accessible in print, or otherwise available; therefore it is included here as an appendix for reference.

| Burial | Military Organization | Sex | Age | Cause of Death |
|---|---|---|---|---|
| A | $9^{th}$ Infantry Regiment | Unknown | Unknown | Combat Related |
| B | Unknown | Unknown | Unknown | Combat Related |
| F | Unknown | Unknown | Unknown | Combat Related |
| G | Unknown | Unknown | Unknown | Combat Related |
| H | Unknown | Unknown | Unknown | Combat Related |
| I | Unknown | Unknown | Unknown | Combat Related |
| K | $3^{rd}$ Battalion, $8^{th}$ Cavalry Regiment | Unknown | Unknown | Combat Related |
| P | $21^{st}$ Infantry Regiment, $24^{th}$ Infantry Division | Male | 30 | Combat Related |
| S | $9^{th}$ Infantry Regiment, $2^{nd}$ Infantry Division | Male | 27 | Combat Related |
| T | G Company, $8^{th}$ Calvary Regiment | Male | 17-19 | Combat Related |
| V | $24^{th}$ Infantry Regiment, $25^{th}$ Infantry Division | Male | 17-20 | Combat Related |
| W | $1^{st}$ Battalion, $8^{th}$ Calvary Regiment | Unknown | Unknown | Combat Related |
| X | Army $9^{th}$ Division | Unknown | Unknown | Combat Related |
| Y | Unknown | Unknown | Unknown | Combat Related |
| Z | Unknown | Unknown | Unknown | Combat Related |
| AA | Unknown | Unknown | Unknown | Combat Related |
| BB | Unknown | Unknown | Unknown | Combat Related |
| DD | Unknown | Unknown | Unknown | Combat Related |
| EE | Unknown | Unknown | Unknown | Combat Related |
| FF | $25^{th}$ or $2^{nd}$ Infantry Division | Unknown | Unknown | Combat Related |
| GG | $25^{th}$ or $2^{nd}$ Infantry Division | Unknown | Unknown | Combat Related |
| HH | $25^{th}$ or $2^{nd}$ Infantry Division | Unknown | Unknown | Combat Related |
| II | Unknown | Unknown | Unknown | Combat Related |
| JJ | Unknown | Unknown | Unknown | Combat Related |
| KK | Unknown | Unknown | Unknown | Combat Related |
| LL | Unknown | Unknown | Unknown | Combat Related |
| MM | Unknown | Unknown | Unknown | Combat Related |
| NN | Unknown | Unknown | Unknown | Combat Related |
| OO | Unknown | Unknown | Unknown | Combat Related |
| RR | Unknown | Unknown | Unknown | Combat Related |
| SS | Unknown | Unknown | Unknown | Combat Related |

| Burial | Artifacts Associated Inside Burial | Artifacts Outside Burial |
|---|---|---|
| A | 1 fragment of unidentified cloth, 1 possible sunglass fragment | None |
| B | Casket, two rubber boot soles, inconsistent with U.S. issue, several batteries, metal can of rifle bore cleaner, unidentified metal lid | White cross |
| F | Plastic bag containing left tibia and fibula, various bones of left foot and ankle, two I.D. tags, one metal chain, laminated WWII discharge card | None |
| G | Commingled remains, 2 buttons, several pieces of fabric, piece of metal | None |
| H | Right femur shaft, machine gun, eleven .45 caliber rounds, military compass, 2 fountain pens, (one made in USA one in China) unidentified buckle, numerous leather strap fragments, recent garbage associated with house | None |
| K | 10 tooth crowns, portions of several long bone shafts, shoe/boot lace, 3 buttons, 7 metal pieces-possibly part of belt buckle | 22 buttons, 2 pieces of unidentified fabric, portions of 3 bullets, plastic comb, lead pencil piece, pieces of a plastic spoon, 2 pottery shards |
| P | 2 ID tags, one Zippo lighter, one Ronson lighter | None |
| S | One U.S. penny, three Korean coins, 23 buttons, pen, piece of comb, military belt buckle, scraps of cloth, mechanical pencil, thread lengths-elastic, broken pottery pieces | None |
| T | Brass buckle, three .30-06 caliber shell casings lying against left side of skull, two identification tags, one near chest region, one under occipital portion of cranium | Among entire excavation site (i.e., three test pits): eight live and 327 spent .30-03 caliber rounds, 37 .30-06 caliber machine gun links, one M-1 barrand "En Bloc Clip," two .30 caliber shell casings, one grenade pin, one canteen cup, nine C-ration packet pieces , four tent pole end pieces, one belt portion/buckle/tip (fastened), 27 buttons, one JP-38 can opener, one web belt accessory clip, three tope pieces, 13 cloth pieces, six newspaper pieces |

| | | |
|---|---|---|
| V | 38 military buttons, and one possible chewing gum wrapper | None |
| W | Pocket knife, U.S. nickel, a Zippo lighter, hair comb fragments, engraved ring w/out discernable markings, shaving brush case, three religious medallions, one lock key, numerous uniform buttons, leather fragments, small glass vials, one knit glove, misc. metal pieces, empty food packets, numerous eyelets, six ID tags | Hand grenade, anti-personal land mine |
| X | Possible leather glove fragment, metal unit insignia pin, small metal buckle, one brown plastic 4-hole button | Several unfired M-1 clips, one M-1 carbine magazine, and multiple empty M-1 clips |
| Y | Numerous helmet liner fragments, a fragment of black plastic comb, a possible mother-of-pearl button, four brown buttons, one black button, one unidentified piece of fabric, unfired M-1 Garand round, and a possible M-1 clip fragment | None |
| Z | One metal starburst button, fired M-1 Garand round, C-ration can fragments, several coffee packets, chocolate foil wrapper, possible battery core | None |
| AA | A possible fabric belt loop, two pieces of plastic, numerous C-ration cans/can parts, numerous pieces of foil, coffee packet | None |
| BB | Pocket knife, one metal belt buckle with image of bull and words, "Far Ming," four green buttons, one small green 2-hole button, unfired M-1 round, numerous coffee packets, P-38 can opener, numerous pieces of foil | None |
| DD | None | 17 brown 4-hole buttons, two black 4-hole buttons , one metal buckle, possible unfired .45 caliber round |
| EE | Seven canvass strap fragments, two metal equipment buckles, three metal parachute buckles, one metal latch, one melted piece of plastic with a canvass strap | Unknown |
| FF | None | None |
| GG | See "other" | A rusted lid to a possible ration can and a fragment of shrapnel |
| HH | One C-ration can fragment, an empty M-1 rifle magazine, a fragment of plastic soap dish, a 7.62 mm casing, a fragment of | Bullets, casings, and other military equipment found in vicinity, but not retained nor |

| | | |
|---|---|---|
| | unidentified rubber and a fragment of a red toothbrush | specified where exactly |
| II | Two boot fragments | None |
| JJ | Multiple small green plastic buttons (various configurations.) one small metal eyelet, one top of a metal pull-the-dot type fastener. one small metal strap cinch | Screening of the previously dug trench soil recovered only a few scraps of unidentified fabric |
| KK | One metal shovel blade of local origin, one full B.A.R. .30 caliber clip and multiple assorted small arms rounds and casings, one small plastic button, multiple small metal buttons, one small metal container, one metal pen clip, one small metal d-ring, two small metal studs, one large metal buckle, one medium metal strap cinch, one small metal cap (function unknown,) one small metal eyelet | Various multiple fired/unfired small arms rounds, multiple boot fragments, possible battlefield litter, visible surface cluster of bone fragments, one metal canteen, multiple boot fragments, soles and uppers, multiple small metal buttons, two medium metal buckles, one small metal buckle, multiple small arms bullets, casings, and unfired rounds of U.S. and non-U.S. origin including two additional empty B.A.R. .30 caliber clips, *associated artifacts also in provenience to burial LL |
| LL | One fragment of lamination plastic, multiple small metal buttons, multiple small plastic buttons, multiple .30 caliber rounds of U.S. origin, one partial woven fabric glove, multiple leather boot fragments associated with tibia and fibula | Artifacts associated with KK also associated with LL |
| MM | Remains of at least three individuals. three tibiae found | None |
| NN | Oval-shaped metal tag found wedged under the left angle of the mandible of individual 2 (the more easterly of the two) well into the area that would have been covered by soft tissue and pressed close to the underside of the bone in such a way that it is unlikely to have settled in that position | None |
| OO | Remains of two individuals, one of Mongoloid origin | Tree stump as marker |
| RR | American M-1 steel helmet was recovered between 20 to 40 cm below surface directly above left knee of upper individual, upper burial contained Chinese copy of Soviet-bloc 82mm projectile with a point-contact | None |

| | | |
|---|---|---|
| | detonating fuse located parallel to the left tibia, U.S. buttons associated with upper: large 4-hole O.D. green buttons, brown cat's eye 2-hole buttons, an metal "burst of glory" post buttons, two 9mm pistol cartridges with 9mm W.R.A. head-stamps recovered from the chest area of the upper burial. M-1 (American) steel helmet and associated parts were associated with upper burial. Lower burial contained communist star cap badge recovered from left hip area of lower burial, U.S. issued large 4-hole O.D. buttons; brown cat's eye 2-hole buttons, metal "burst of glory" post buttons, partial boot with a leather upper and rubber sole, an a knit, gray-green woolen glove | |
| SS | Excavated in direct association with Individual #8, multiple plastic uniform buttons of various configurations | |

| Burial | Orientation of Grave | Orientation of Remains | Obscuration |
| --- | --- | --- | --- |
| A | Head: 20 degrees magnetic north | Head: 20 degrees magnetic north | Second burial |
| B | Head: north, feet: south | Head: north, feet: south | Second burial |
| F | Unknown | Unpatterned | Second burial |
| G | Unknown | Commingled/unpatterned | Second burial |
| H | Unknown | Unpatterned | Second burial |
| K | Approximately north to south | Teeth: south, bone: middle | Evidence of disturbance, possible that individual not intact when buried |
| P | Unknown | Unknown | Second burial |
| S | Unknown | Unknown | Evidence of disturbance |
| T | Northwest to southeast | Supine, head to northwest, see position of remains..... | Primary burial, done after some decomposition |
| V | North to south | Remains interred one on top of the other, in reverse orientation | Burial encountered by KPA officials, exposed a left femur which was repositioned, and area where #1's cranium, torso, and left arm would have been exposed, but missing at arrival of CIL personnel |
| W | Northeast to southwest | One set found above in plastic bag, commingled remains of at least ten individuals found below | Believed undisturbed since wartime burial |
| X | East to west | Supine, see position of remains.... | Originally discovered by Joint Investigation Element |
| Y | North to south | Commingled | Originally discovered by KPA officials |
| Z | East to west | Supine, knees bent | Possible tampering, incorrect anatomical positioning of several elements, i.e., radius and ulna associated with wrong humeri |
| AA | Northwest to southeast | Commingled | Disarticulated and jumbled with cans and debris, evidence suggests recent reburial |
| BB | Northwest to southeast | Disarticulated | Disarticulated, evidence suggests recent reburial |
| DD | East to west | Scattered/disarticulated | Rodent gnawing present, |

| | | | |
|---|---|---|---|
| | | | remains extensively dispersed due to plowing and other actions of farmer |
| EE | Northeast to southwest | Commingled | Missing portions of skeletons |
| FF | Northeast to southwest | Disarticulated | Secondary burial |
| GG | West to east | Commingled | Evidence suggests recent secondary burial |
| HH | South to north | Commingled/slightly patterned | Evidence suggests secondary burial |
| II | North to south | Commingled | Witness testifies to reburial, evidence of older secondary burial than witness claims |
| JJ | North to south | Individual on top: feet to north, individual below: feet toward south | Secondarily deposited. likely from erosion |
| KK | North to south | Unpatterned | Plow scattered bones, some found on surface, secondary burial remains found between large stones |
| LL | North to south | Southeast to northwest | Approximate anatomical position, remains found between large stones |
| MM | Unknown | Unknown | Glue found on numerous cranial elements |
| NN | Unknown | Both: head to east, lower body to west | Approximate anatomical order |
| OO | East to west | North to south | Secondary burial |
| RR | East to west | Interred head to toe, and superimposed | Possible disturbance from new road construction above |
| SS | North to south | Mostly north to south, details in position of remains | Some scattering of remains suggests disturbance |

| Burial | Position of Remains | Other |
|---|---|---|
| A | Arranged in approximate anatomical position | Smaller, more fragile bones lost from primary burial pit |
| B | Arranged in approximate anatomical position | Remains assumed to be other than American |
| F | Grouped within plastic bag | Items discovered during construction of house and reburied less than two weeks before second recovery |
| G | Commingled/ unpatterned | Burial shape is burial pit |
| H | Unpatterned | Site expanded to 15.5 square meters to accommodate the provenience of artifacts found |
| K | Teeth recovered in south end, bone found clustered in middle | Part of burial area said to have been excavated and re-covered previously |
| P | Unknown | Individual recovered and reburied prior to arrival of CIL personnel |
| S | Unknown | Individual believed to have died of malnutrition at POW camp |
| T | See "orientation of remains" | Witness testifies location, claims soldier had fallen off a cliff and buried at base of hill, burial marked my large flat rock, large rocks border narrow grave, soil consists of rocks and silty clay, it would be very difficult to dig a wide pit for burial in this soil |
| V | Individual #1 consisted of lower limbs and right arm in articulated position, lying on right hip and arm, feet pointing northeast, on top of #2. Individual #2 consisted of cranium pointed north under #1's feet, virtually complete skeleton in prone extended position, face to right (east,) left arm bent around top of cranium | Witness testifies to burial of three under "wild grape tree" only one identification made |
| W | Commingled/ unpatterned | Tarp placed by KPA covered bag of human remains, discovered during construction of canal and reburied at site, below are remains of at least ten individuals, witness found individual with artifacts during construction and reburied in bag, led personnel to site |
| X | Supine, legs slightly flexed, knees raised | Burial pit also possible fighting position, witness testifies to location |

| | | |
|---|---|---|
| Y | Commingled/ unpatterned | Witness leads investigator to burial, loose dirt suggests very recent reburial, goes against witness claim that they had been moved there over a year ago, coordinates are approximate |
| Z | Supine, knees bent | Coordinates are approximate, three of one hundred fighting positions excavated, located by witness who expressed hostility toward Americans, burial 1 witness testifies to seeing Americans bury soldier, however, portions of remains show obvious signs of repositioning: note that witness was coached by KPA members |
| AA | Commingled/ unpatterned | Burial 2 witness testifies two stories: found remains scattered on hill top by animals then he reburied in 1951, KPA officials then said witness found remains on surface in 1960 then reburied in fighting position |
| BB | Disarticulated | No witness testimony |
| DD | Scattered/disarticulated | Farmer plowing field discovered a skull and some long bones, threw them down a nearby slope, second witness testifies that he saw KPA soldiers with American prisoners, one shot while trying to escape, buried in approximate location that farmer found remains, coordinates are approximate, articulated hand found indicates original intact burial |
| EE | Disarticulated and tightly clustered within the fighting position | Coordinates are approximate, no distinction made where artifacts found, numerous C-ration cans and coffee packets, KPA officials claim dead soldiers from American Airborne units gathered by KPA soldiers and buried in fighting position, story not confirmed by witness |
| FF | Disarticulated | While repairing road, witness came across human remains associated with American-style buttons and boots, he reburied the remains at the top of the escarpment adjacent to the road |
| GG | Commingled/ disarticulated | Evidence suggests recent reburial, KPA noted that local loggers periodically throw discovered bones into known fighting positions, no distinction made where artifacts found |
| HH | Attempted patterning | Remains attempted to be put in anatomical order, however mistakes made indicate perpetrator had little knowledge of human osteology, burial pit also thought to be fighting |

| | | |
|---|---|---|
| | | position |
| II | Commingled | Witness claimed he had reburied human remains that were picked up from a railroad bed five years earlier, findings are inconsistent with story |
| JJ | Both in extended prone position, in approximate anatomical order | Overwhelming evidence suggests individual could not have been buried for 50+ years in this location, this contradicts witness testimony which stated remains buried in 1951 |
| KK | Unpatterned, see "other" | Local farmer claimed to have found recently some surface human remains while plowing his field, pit is too small to have accommodated a human body, remains were buried after defleshing, burial found in exact location outlined in witness testimony |
| LL | In approximate anatomical order | To fit into the small pit, the body had to be placed in a highly flexed position, facing upwards, and lay crossways in the pit, loose burial fill and smallness of pit (too small to have accommodated a fleshed body) plus finding of a third tibia in disturbed burial belonging to individual in relatively intact burial, all indicate burials are secondary, additionally, individual in burial 2 determined to be of non-U.S. origin, possible south Korean soldier armed with U.S. issued items or unrelated individuals buried with U.s. related items to appear to be U.S. soldier |
| MM | Approximate anatomical positioning | Witness provides second hand information, story told to him by primary witness before his death, said to have found remains on surface and reburied them, evidence indicates remains were originally in storage and only recently deposited at this site, presence of glue on cranial fragments and lack of evidence at supposed primary burial site suggests fraudulent testimony on part of witness, site considered completely fabricated, coordinates are approximate |
| NN | Lower extremities of both individuals seem to have been folded under so that the feet are under the head | KPA claim that the site was located by a witness though none was provided, burial located prior to CIL arrival, wall was reportedly used as landmark by which the witness was abele to locate the remains, lack of soil development and wall's recent construction suggests secondary burial |

| | | |
|---|---|---|
| OO | Neatly piled but not in anatomical order | KPA claim witness, not provided, testified to having buried human remains 15 years ago, though no information regarding primary location was given, CIL personnel led to site marked by tree stump with 30 rings, remains found in proximity to tree, though lack of root development indicates burial not 15 year old, one set of remains determined to be of non-U.S. origin was left behind |
| RR | Upper burial was in reclining position with knees apart over the torso of the lower burial, left arm folded across chest and right upper arm was parallel to the torso with the forearm folded back toward the head, facial area was collapsed and partially destroyed, lower burial was partially flexed on its left side with the head rotated toward the base of the feature, the legs were bent at the knee and right leg terminated in a leather boot, no skeletal elements recovered from boot, arms were partially flexed in front of the torso with the right arm terminating in a knit glove, skeletal elements were removed from glove | Witness states that as a child playing by granite rock, witnessed killing of two American prisoners by aircraft fire, witnessed older villagers burying Americans near rock, burial pit shallow oval, Soviet-bloc equipment and American issue equipment found, however, U.S. issued equipment found in both upper and lower burials, disorganized nature of burial suggests that the individuals were not interred by friendly forces, root penetration into skeletal elements suggests long-term internment, findings consistent with witness testimony, considered primary burial location |
| SS | Individual #1: located at the southern end of the burial pit, upper portion, head points south, facing east wall, laying on right side, legs of #3 underneath. Individual #2: on right side, head to north facing up, against west wall of burial pit, upper part of burial in close proximity to #s 4, 5, and 6. Individual #3: against east wall of burial pit head to north, facing down/west, legs located | Two witness statements were provided by the KPA officials concerning the possible burial location of human remains believed to be a U.S. soldiers, the KPA anthropologist agreed that the remains of #12 were of a probable mongoloid, the KPA officials would not permit their repatriation to the CILHI despite their association with multiple artifacts of undisputed U.S. origin |

| | | |
|---|---|---|
| | under #1 with feet in south-east corner of burial pit. Individual #4: located alongside #s 1 and 3 and underneath a portion of #2, head to north and the feet along the southwest end of the burial pit, positioned on stomach with head located under the legs of #s 2 and 5, two ID tags on a chain were recovered around the neck of this individual, the right arm was over the head and the left arm was located under the chest. Individual #5: head located to north, legs in close proximity to #s 2 and 6, located in the middle of .burial pit Individual #6: located under #2, along west wall of pit, head to north, facing east, in close proximity to #s 2 and 5. Individual #7: head located directly under pelvis of #4, head to south, positioned on his stomach, on the floor of pit, communication device located under cranium, portion of one foot located under skull of #8. Individual #8: head to south, laying on his back, draped over a hump in bottom of pit, arms over chest, well preserved and mostly complete. Individual #9: partially scattered near the top of the feature, with the other portions (cranium, pelvis, and left arm) still apparently intact above #8. Individual #10: lay beneath #8 and #9, with head northern edge of pit and feet within thoracic area of #8, | |

| | | |
|---|---|---|
| | positioned face down with left arm in flexed position near head, and his right arm extended under the cranium of #9. Individual #11: lay directly to the west of #10 and partly on top, with cranium partially disarticulated and lodged against the northern pit edge. Individual #12: remains lay directly underneath those of #11 and was bottommost set of remains, good condition and nearly complete | |

Location Key

| # | Location |
|---|---|
| 1 | Yongchu-Li District. Kujang County, Democratic People's Republic of Korea |
| 2 | Republic of Korea Army Guard Post, Kangwon, Province, Republic of Korea |
| 4 | Kujang County, P'yongan-Pukto Province, Democratic People's Republic of Korea |
| 6 | Unsan County, Democratic People's Republic of Korea |
| 10 | Chonui, South Korea |
| 13 | Chulwan County, South Korea |
| 15 | Sangyi-ri Village, Kujang County, P'yongan-Pukto Province, Democratic People's Republic of Korea |
| 16 | Hwaong-Ri Village, Unsan Province, Democratic People's Republic of Korea |
| 17 | Kujang County, Democratic People's Republic of Korea |
| 18 | Kujang County, South Pyongan Province, Democratic People's Republic of Korea |
| 19 | Kaech'on-Si District, P'yongan-Namdo Province, Democratic People's Republic of Korea |
| 21 | Changjin District, Hamgyong Province, Democratic People's Republic of Korea |

## A.2 Numbering System for Original Korea data

| CILHI LOCATION | THESIS LOCATION | THESIS CEMETERY | THESIS GRAVE | CILHI REMAIN | THESIS REMAIN |
|---|---|---|---|---|---|
| 1 | 4 | 7 | 22 | A | 1140 |
| 2 | 5 | 8 | 23 | B | 1141 |
| 4 | 6 | 9 | 24 | F | 1142 |
| 4 | 6 | 9 | 25 | G | 1143 |
| 4 | 6 | 9 | 25 | G | 1144 |
| 4 | 6 | 9 | 26 | H | 1145 |
| 6 | 7 | 10 | 27 | K | 1146 |
| 10 | 8 | 11 | 28 | P | 1147 |
| 13 | 9 | 12 | 29 | S | 1148 |
| 6 | 7 | 10 | 30 | T | 1149 |
| 15 | 10 | 13 | 31 | V | 1150 |
| 15 | 10 | 13 | 31 | V | 1151 |
| 4 | 6 | 9 | 33 | X | 1152 |
| 4 | 6 | 9 | 35 | Z | 1153 |
| 4 | 6 | 9 | 37 | BB | 1154 |
| 4 | 6 | 9 | 38 | DD | 1155 |
| 4 | 6 | 9 | 39 | EE | 1156 |
| 4 | 6 | 9 | 39 | EE | 1157 |
| 4 | 6 | 9 | 40 | FF | 1158 |
| 17 | 12 | 15 | 42 | HH | 1159 |
| 18 | 13 | 16 | 44 | JJ | 1160 |
| 18 | 13 | 16 | 44 | JJ | 1161 |
| 19 | 14 | 17 | 45 | KK | 1162 |
| 19 | 14 | 17 | 46 | LL | 1163 |
| 19 | 14 | 17 | 48 | NN | 1164 |
| 19 | 14 | 17 | 48 | NN | 1165 |
| 19 | 14 | 17 | 49 | OO | 1166 |
| 19 | 14 | 17 | 49 | OO | 1167 |
| 6 | 7 | 10 | 50 | RR | 1168 |
| 6 | 7 | 10 | 50 | RR | 1169 |

# Appendix B – Coding System and Definitions for Fields and Entries for Access Database

## B.1 Cemetery Table

-CemeteryID (primary key)

*Used to identify individual cemeteries in the database*

-Unique number to identify the cemetery (Auto-number)

-Name

*Used to identify individual cemeteries in the database*

-Proper name (if applicable) of cemetery

-UTMGR

*The geographic location of the cemetery in reference to the world (to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial)*

- Universal Transverse Mercator Grid Reference

-Type

*The known (or hypothesized) permanency of the cemetery (i.e. whether or not burial site is intended as final resting place)*

-enter code

1 Permanent
2 Temporary
3 Unknown

-LocationID (foreign key)

*Used to link Cemetery Table with Location Look-up Table*

-enter in appropriate LocationID

### B.1.1 LocationID (linked table)

-LocationID (primary key)

*Used to link the appropriate record in the Cemetery Table with the Location Look-up Table*

-enter unique number to identify Location (Auto-number)

-LocationName

*Used to identify city and country in which cemetery is located*

-enter in city and country name

## B.2 Grave Table

-GraveID (primary key)

*Used to identify an individual grave*

-enter unique number to identify grave (Auto-number)

-UTMGR

*The geographic location of the cemetery in reference to the world (to estimate ethnic and religious affiliation of those buried or those responsible for burial)*

-enter the Universal Transverse Mercator Grid Reference

-Easting (mapping measurements/coordinates)

*((if applicable); to maintain provenance; for GIS application; to estimate ethnic and religious affiliation of those buried or those responsible for burial)*

-enter Easting coordinates

-Northing (mapping measurements/coordinates)

*((if applicable); to maintain provenance; for GIS application; to estimate ethnic and religious affiliation of those buried or those responsible for burial)*

-enter Northing coordinates

-Orientation

*The orientation (polar direction) of the grave is directed in relation to magnetic north (to maintain provenance; suggest normative or aberrant behaviour)*

-enter degrees (0.0 = Unknown orientation; 360.0 = North)

-OrientRange

*The range the orientation (above) of the grave is directed in relation to magnetic north (to maintain provenance; suggest normative or aberrant behaviour)*

-enter range

| | |
|---|---|
| 1 | 1-45° |
| 2 | 46-90° |
| 3 | 91-135° |
| 4 | 136-180° |
| 5 | 181-225° |
| 6 | 226-270° |
| 7 | 271-315° |
| 8 | 316-360° |

-Date

*Date or time period of interment using the following dating and coding system (establish background (type of conflict, forces involved))*
(Since archaeological time periods are not consistent between continents and, in some instances, between countries, only time spans in reference to years will be used (compared to the dating system incorporated by Chartrand and Miller 1994)

-enter code:

| | |
|---|---|
| >10,000 BC | 100.0 |
| 10,000 – 3,5000 BC | 110.0 |
| 3,500 – 2,000 BC | 120.0 |
| 2,000 – 600 BC | 130.0 |
| 600 BC – AD 0 | 140.0 |
| AD 0 – AD 400 | 200.0 |
| 1st century | 201.0 |
| 2nd century | 202.0 |
| 3rd century | 203.0 |
| 4th century | 204.0 |
| AD 400 – AD 800 | 300.0 |
| 5th century | 305.0 |
| 6th century | 306.0 |
| 7th century | 307.0 |
| 8th century | 308.0 |
| AD 800 – AD 1100 | 400.0 |
| 9th century | 409.0 |
| 10th century | 410.0 |
| 11th century | 411.0 |
| AD 1100 – AD 1600 | 500.0 |
| 12th century | 512.0 |
| 13th century | 513.0 |
| 14th century | 514.0 |
| 15th century | 515.0 |
| 16th century | 516.0 |
| AD 1600 – present | 600.0 |
| 17th century | 617.0 |
| 18th century | 618.0 |
| 19th century | 619.0 |
| 20th century | 620.0 |
| 21st century | 621.0 |

*If the exact date is known, use the category code in conjunction with this date(e.g. the year 1641 is coded as 617.1641 (code.year). If the day, month and year are known, code as in the following example (17 September 1944 is coded as 620.17091944 (code.daymonthyear)).*

-Length

*Dimensions of the grave (length x breadth x depth) in meters*
*(to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns)*

-enter length

-Breadth

*Dimensions of the grave (length x breadth x depth) in meters (to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns)*

-enter breadth

-Depth

*Dimensions of the grave (length x breadth x depth) in meters (to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns)*

-enter depth

-CemeteryID (foreign key)

*Used to link the Grave Table with the appropriate record in the Cemetery Table*

-enter in appropriate CemeteryID number

B.2.1 OBSCURATION (linked table)

*Salience (visibility) of grave; affected by intentional or unintentional obscuration (coverage and/or disturbance), including the planting of flora or the construction of roads or buildings. Use the following definitions and coding system (characteristics that (may) suggest the intent of those responsible for burial; occurrence may be patterned*

-Degree

-enter code (0-5)

0 no obscuration (100% visibility)
1 1-20% coverage (percentage of grave obscured/disturbed)
2 21-40% coverage (percentage of grave obscured/disturbed)
3 41-60% coverage (percentage of grave obscured/disturbed)
4 61-80% coverage (percentage of grave obscured/disturbed)
5 81-100% coverage (percentage of grave obscured/disturbed)

-Type

*If obscuration is present, indicate type NB: SALIENCE = VISIBILITY (possible patterns in type may appear)*

-enter one of the following

1 Trees/bushes
2 Road/pavement
3 Building
4 Secondary Burial
5 Ploughing/Farming Activity
6 Other

- GraveID (foreign key)

*Used to link the Salience Table with the appropriate record in the Grave Table*

-enter in appropriate GraveID number

**B.3 Remains Table**

-RemainsID (primary key)

*Used to identify an individual set of remains*

-enter unique number to identify the set of remains (Auto-number)

-Easting (mapping measurements/coordinates)

*Used when the remains are located in a mass grave*
*(to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns)*

-enter Easting coordinates

-Northing (mapping measurements/coordinates)

*Used when the remains are located in a mass grave*
*(to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns)*

-enter Northing coordinates

-TMB (General terminology regarding location)

*Used when the remains are located in a mass grave*
*(to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns;)*

-enter code (in reference to the level)

1 Top
2 Middle
3 Bottom

-RCL (General terminology regarding location)

*Used when the remains are located in a mass grave*
*(to maintain provenance; to estimate ethnic and religious affiliation of those buried or those responsible for burial; identification of patterns;)*

-enter code (in reference to Northing and Easting positioning):

1 Right
2 Centre
3 Left

-Articulation

*Level of the articulation (bones in the correct position and in conjunction with the correct anatomical element(s)) of the remains (based on the percentage of the remains present) using the following definitions and coding system*

-enter code

1 1-25%
2 26-50%
3 51-75%
4 76-100%

-Date

*Date or time period of interment using the following dating and coding system (establish background (type of conflict, forces involved))*
Use Date coding system used for Grave Table (see above)

-Orientation

*The orientation (polar direction) of the remains (the direction the head lies in relation to the line between the skull and the centre of the pelvis (Heizer 1958: 65) or the direction the body is facing (Sprague 1968: 482)) within the grave in relation to magnetic north (the cranium or torso being the point of origin)*

-enter in degrees (0.0 = Unknown orientation; 360.0 = North)

-OrientRange

*The range the orientation (above) of the grave is directed in relation to magnetic north*

-enter range

| | |
|---|---|
| 1 | 1-45° |
| 2 | 46-90° |
| 3 | 91-135° |
| 4 | 136-180° |
| 5 | 181-225° |
| 6 | 226-270° |
| 7 | 271-315° |
| 8 | 316-360° |

-Age

*Estimated or known age of the individual using the following categories and coding system (for statistical analysis of age composition)*

-enter code

| | |
|---|---|
| 0.0 | 0 - unknown |
| 110.0 | 1 month – 6 years |
| 120.0 | 7 –12 years |
| 130.0 | 13-19 years |
| 210.0 | 20 – 29 years |
| 220.0 | 30 – 39 years |
| 310.0 | 40 – 49 years |
| 510.0 | 50 – 59 years |
| 520.0 | 60 – 69 years |
| 530.0 | 70 – 79 years |
| 540.0 | 80 – 89 years |
| 100.0 | ≦ 18 years |
| 200.0 | 19 – 35 years |
| 250.0 | 25 – 45 years |
| 300.0 | 35 – 50 years |
| 400.0 | ≦ 50 years |
| 500.0 | ≧ 50 years |

*For the known exact age, use the category code in conjunction with the exact age (e.g. 47 years old = 310.47)*

-Sex

*Estimated or known biological sex of the individual*

-enter code

| | |
|---|---|
| 1 | Male |
| 2 | Female |
| 3 | Undetermined |

-Container

*If remains are placed within, enclosed by, or covered by a secondary object*

-enter appropriate Container code

1 None
2 Blanket
3 Shroud
4 Coffin
5 Body Bag
6 Other
7 Plastic Bag

-ArmID

*The upper limb's physical position within the grave in relation to the body*

-enter appropriate position code

1 Side (arms at side extended)
2 In/On Front (folded over front of body)
3 Behind (behind the body)
4 Above Head (outstretched from body toward skull)
5 Outstretched
6 Flexed (bent/flexed)
7 Undetermined (disarticulated, but present)

-HeadID

*The head's position/direction within the grave in relation to the body*

-enter appropriate position code

1 Supine
2 Prone
3 Face Left (left side of skull facing top of grave (over left shoulder))
4 Face Right (right side of skull facing top of grave (over right shoulder))
5 Face Down (front of skull facing end of grave (opposite end of body))
6 Face Up (front of skull facing end of grave (up turned toward grave end))
7 Undetermined

-PositionID

*The body's overall physical position within the grave*

-enter appropriate position code

1 Extended-Supine
2 Extended-Prone
3 Extended-Right (on the right side/left side facing up)
4 Extended-Left (on the left side/right side facing up)
5 Crouched
6 Flexed
7 Flexed-Right (on the right side/left side facing up)
8 Flexed-Left (on the left side/right side facing up)
9 Supine
10 Prone
11 Flexed-Supine
12 Unpatterned/disarticulated
13 Undetermined
10 Unknown

B.3.1 CAUSE OF DEATH TABLE (linked table)
*Determined or estimated cause of death*

-Cause
-Enter cause code

| | | | |
|---|---|---|---|
| 1 | Combat Related | 13 | PFW-Lower body |
| 2 | GSW-Head | 14 | Puncture-Head |
| 3 | GSW-Upper body | 15 | Puncture-Upper body |
| 4 | GSW-Lower Body | 16 | Puncture-Lower body |
| 5 | SFT-Head | 17 | Malnutrition/Disease |
| 6 | SFT-Upper body | 18 | Undetermined |
| 7 | SFT-Lower body | 19 | Other |
| 8 | BFT-Head | 20 | Other-Upper body |
| 9 | BFT-Upper body | 21 | Other-Lower body |
| 10 | BFT-Lower body | 22 | Other-Head |
| 11 | PFW-Head | 23 | N/A |
| 12 | PFW-Upper body | 24 | Natural |

*GSW (Gun shot wound)* *SFT (Sharp force trauma)*
*BFT (Blunt force trauma)* *PFW (Projectile fragment wound)*

-RemainsID (foreign key)
*Used to link the Cause of Death Table with the appropriate record in the Remains Table*
-enter appropriate RemainsID number

B.3.2 MUTILATION/TRAUMA TABLE (linked table)
*Peri- or Post-mortem trauma (defacement) deliberately inflicted upon the deceased, prior to or immediately after death*

-Type
*Indicate the type of mutilation present and the body area(s) affected*
-enter the type of mutilation/trauma (i.e. scalping, etc.)
- BodyAreaID (foreign key)
*Used to link the Mutilation Table with the appropriate record in the BodyArea Look-up Table*
-enter appropriate BodyAreaID

-RemainsID (foreign key)
*Used to link the Mutilation Table with the appropriate record in the Remains Table*
-enter appropriate RemainsID number

B.3.3 COMMINGLING TABLE (linked table)
*Present if one or more sets of remains physically intrudes on another within a grave in relation to the amount of coverage/intrusion of the primary set of remains. Enter if commingling present. Use the following definitions and coding system*

-Commingling
-enter code

1 1-25% coverage
2 26-50% coverage
3 51-75% coverage
4 76-100% coverage

-RemainsID (foreign key)

*Used to link the Commingling Table with the appropriate record in the Remains Table*

-enter appropriate RemainsID number

-ID number of the set of remains being impacted

-RemainsID2

*Used to identify the set of remains that are encroaching/commingled with RemainsID*

-enter appropriate RemainsID number (of remains intruding)

B.3.4 SKELETAL COMPLETENESS TABLE (linked table)

*The totality of the remains using the following coding system (suggest post-mortem trauma/movement, normative or aberrant behaviour)*

-List of all elements

-Enter appropriate code in each box – All items

C - Present Complete
F - Present Fragmentary
A - Absent
M - Majority Present (* items only)

* Items Code Justification

**Cervical Vertebrae (7)***
C = all 7 present
M = 4-6 (out of 7) present
F = 1-3 (out of 7) present
**Thoracic Vertebrae (12)***
C = all 12 present
M = 6-11(out of 12) present
F = 1-5 (out of 12) present
**Lumbar Vertebrae (5)***
C = all 5 present
M = 3-4 (out of 5) present
F = 1-2 (out of 5) present
**Pelvis (6 elements)***
C = all 6 elements present
M = 3-5 (out of 6) present
F = 1-2 (out of 6) present
**Ribs (12)***
C = all 12 present
M = 6-11(out of 12) present
F = 1-5 (out of 12) present

-Articulation Level

*Level of the articulation (bones in the correct position **and** in conjunction with the correct anatomical element(s)) of the remains (based on the percentage of the remains present) using the following definitions and coding system*

-enter code

1 1-25%
2 26-50%
3 51-75%
4 76-100%

-RemainsID (foreign key)

*Used to link the Skeletal Completeness Table with the appropriate record in the Remains Table*

-enter appropriate RemainsID number

**B.4 Artefact Table**

-ArtefactID (primary key)

*Used to identify artefacts in the database*

-enter unique number to identify the artefact (Auto-number)

-Easting (mapping measurements/coordinates)

*Location of artifact*

*(to maintain provenance)*

-enter Easting coordinates

-Northing (mapping measurements/coordinates)

*Location of artifact*

*(to maintain provenance)*

-enter Northing coordinates

-General Location

*Descriptive artefact position in relation to grave when coordinates are not available and/or not applicable*

*(to maintain provenance; suggest association)*

-enter code

| | |
|---|---|
| 1 | Inside burial |
| 2 | Outside burial |
| 3 | Above burial (fill) |
| 4 | Surface |

-OIU/BBUn

*Vertical position of artefact in relation to remains*

*(to maintain provenance; suggest association)*

-enter code

| | |
|---|---|
| 1 | On |
| 2 | In |
| 3 | Under |
| 4 | Beside |
| 5 | Between |
| 6 | Unknown |

-Grave Location

*Descriptive artefact position in the grave when coordinates are not available and/or not applicable, and if location is not "Unknown"*

*(to maintain provenance; suggest association)*

-enter code

| | | | |
|---|---|---|---|
| 1 | North | 1 | North-west |
| 2 | South | 1 | North-east |
| 3 | East | 1 | North-centre |
| 4 | West | 2 | South-west |
| 5 | Centre | 2 | South-east |
| 6 | Entire | 2 | South-centre |
| | | 3 | East-centre |
| | | 4 | West-centre |

-GenTypeID (General Artefact Type)

*Description of artefact using the following classifications (see artefact table)*

-enter type of artefact code

| | |
|---|---|
| 1 | Armaments, etc |
| 2 | Clothing |
| 3 | Personal Item |
| 4 | Tool/Equip |
| 5 | Stone |
| 6 | Flora |
| 7 | Fauna |
| 8 | Unidentified |
| 9 | Composite |

-Quantity

*Artefact quantity*

-enter number

-RemainsID (foreign key)

*Used to link the Artifact Table with the appropriate record in the Remains Table*

-enter appropriate RemainsID number

-GraveID (foreign key)

*Used to link the Artifact Table with the appropriate record in the Grave Table (when no applicable RemainsID - not associated with a set of remains)*

-enter appropriate GraveID number

-CemeteryID (foreign key)

*Used to link the Artifact Table with the appropriate record in the Cemetery Table (when no applicable RemainsID or GraveID – not associated with a set of remains or a grave)*

-enter appropriate CemeteryID number

-Type

*Description of artefact using the following classifications*

-enter type of artefact

| | | | |
|---|---|---|---|
| 996 | Bullet, cases, etc | 59 | Unidentified |
| 997 | Civilian Clothing | 60 | Other |
| 998 | Mil Uniform | 61 | Sack/bag |
| 999 | Coffin | 62 | Ammunition belt |
| 1 | Bullet | 64 | Wallet |
| 2 | Button | 65 | Watch |
| 3 | Recent Rubbish | 66 | Cable |
| 5 | Wood Fragment | 67 | Rope |
| 6 | Cartridge | 68 | Fastener |
| 7 | Nail/rivet | 69 | Chain mail/lace tag |
| 8 | boot/shoe (frag) | 71 | Religious medal |
| 9 | Boot heel | 72 | Bayonet |
| 10 | lead shot | 73 | Pipe |
| 11 | boot nail | 74 | Suspenders |
| 12 | Trousers | 75 | Scabbard |

| | | | |
|---|---|---|---|
| 13 | Shirt | 77 | Leaves |
| 14 | Cloth | 78 | Tobacco/cig |
| 15 | Finger ring | 79 | Jacket/Sweater |
| 16 | Primer/Flint | 80 | Skirt/Dress |
| 17 | Animal Bone | 81 | Eye Glasses |
| 18 | Screw | 82 | Pendent |
| 19 | Hat | 83 | Scarf |
| 20 | Hook/eye | 84 | Earring |
| 21 | Chain (Personal) | 85 | Long underwear |
| 22 | Coin | 87 | Briefcase |
| 23 | Slug | 88 | Projectile Point |
| 24 | Brick/Cut Stone | 89 | Gun/Rifle tool |
| 25 | Marker (Grave) | 90 | Human Element |
| 26 | Metal Fragment | 91 | .45 calibre bullet |
| 28 | Battery | 92 | .45 calibre-unfired |
| 29 | Lid | 93 | .45 calibre bullet -Colt |
| 30 | ID Tag | 94 | .44/.45 calibre bullet |
| 31 | ID card | 95 | .44-.55 Springfield bullet |
| 32 | Pen/Pencil | 96 | .44 calibre bullet -Henry |
| 33 | Buckle | 97 | .22 calibre bullet |
| 34 | Compass | 98 | .22 calibre-unfired |
| 35 | Bag/Sheeting | 99 | .22 calibre case |
| 36 | shoe/boot lace | 100 | .25 calibre bullet |
| 37 | Lighter | 101 | .25 calibre-unfired |
| 38 | Belt | 102 | .30-03 calibre bullet |
| 39 | Pottery | 103 | .30-03 calibre-unfired |
| 40 | Pocket Knife | 104 | .30-03 calibre case |
| 42 | Hand Glove | 105 | .30-06 calibre bullet |
| 43 | Magazine (Empty) | 106 | .30-06 calibre-unfired |
| 44 | Magazine (Unfired) | 107 | .30-06 calibre case |
| 45 | Strap | 108 | .30 calibre bullet |
| 46 | Toiletries | 109 | .30 calibre-unfired |
| 47 | Food Equipment | 110 | .30 calibre case |
| 48 | Construct Equip | 111 | 7.62 mm-unfired |
| 49 | Helmet | 112 | 7.62 mm calibre bullet |
| 51 | Ordnance | 113 | 7.62 mm case |
| 53 | Gun | 114 | 9mm bullet |
| 54 | Cobble/Rock | 115 | 9mm -unfired |
| 55 | Newspaper, etc | 116 | 9mm case |
| 56 | Pin/Brooch | 117 | .577 Enfield bullet |
| 57 | Latch/lock | 118 | .58 CSA Gardner Bullet |
| 58 | Skeletal Element | | |

-MaterialID

*Material that artifact is constructed of/produced from (where required)*

-enter material type of associated artefact

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Chert | 21 | Glass | 15 | Steel | 28 | Brass |
| 9 | Bone | 22 | Plastic | 16 | Other Metal | 29 | Wood |
| 10 | Other Lithic | 23 | Other | 17 | Ceramic | 30 | Composite |
| 11 | Iron | 24 | Unknown | 18 | Leather | 31 | Flora/Veg. |
| 12 | Bronze | 25 | Mother of Pearl | 19 | Fabric | 32 | Paper |
| 13 | Gold | 26 | Lead | 20 | Fibre | 33 | Copper |
| 14 | Silver | 27 | Rubber | | | 34 | Pewter |

# APPENDIX C – CODING SYSTEM AND DEFINITIONS FOR FIELDS AND ENTRIES FOR SPSS

## C.1 Grave Table

-CemeteryID

*Used to identify individual cemeteries in the database*

-GraveID

*Used to identify an individual grave*

-Type of Cemetery

*The known (or hypothesized) permanency of the cemetery*

-enter code

1 Permanent
2 Temporary

-Orientation

*The orientation (polar direction) of the grave is directed in relation to magnetic north*

-enter degrees (0.0 = Unknown orientation; 360.0 = North)

-OrientRange

*The range the orientation (above) of the grave is directed in relation to magnetic north*

-enter range

1 1-45°
2 46-90°
3 91-135°
4 136-180°
5 181-225°
6 226-270°
7 271-315°
8 316-360°

-Length

*Dimensions of the grave (length x breadth x depth) in meters*

-enter length

-Breadth

*Dimensions of the grave (length x breadth x depth) in meters*

-enter breadth

-Depth

*Dimensions of the grave (length x breadth x depth) in meters*

-enter depth

-Date

*Date or time period of interment using the following dating and coding system (establish background (type of conflict, forces involved))*

(Since archaeological time periods are not consistent between continents and, in some instances, between countries, only time spans in reference to years will be used (compared to the dating system incorporated by Chartrand and Miller 1994)

-enter code:

| | |
|---|---|
| >10,000 BC | 100.0 |
| 10,000 – 3,5000 BC | 110.0 |
| 3,500 – 2,000 BC | 120.0 |
| 2,000 – 600 BC | 130.0 |
| 600 BC – AD 0 | 140.0 |
| AD 0 – AD 400 | 200.0 |
| 1st century | 201.0 |
| 2nd century | 202.0 |
| 3rd century | 203.0 |
| 4th century | 204.0 |
| AD 400 – AD 800 | 300.0 |
| 5th century | 305.0 |
| 6th century | 306.0 |
| 7th century | 307.0 |
| 8th century | 308.0 |
| AD 800 – AD 1100 | 400.0 |
| 9th century | 409.0 |
| 10th century | 410.0 |
| 11th century | 411.0 |
| AD 1100 – AD 1600 | 500.0 |
| 12th century | 512.0 |
| 13th century | 513.0 |
| 14th century | 514.0 |
| 15th century | 515.0 |
| 16th century | 516.0 |
| AD 1600 – present | 600.0 |
| 17th century | 617.0 |
| 18th century | 618.0 |
| 19th century | 619.0 |
| 20th century | 620.0 |
| 21st century | 621.0 |

*If the exact date is known, use the category code in conjunction with this date(e.g. the year 1641 is coded as 617.1641 (code.year). If the day, month and year are known, code as in the following example (17 September 1944 is coded as 620.17091944 (code.daymonthyear)).*

-NoInd

*Number of individual sets of remains in grave*

-Enter the number of individuals

-Obscuration

*Salience (visibility) of grave; affected by intentional or unintentional obscuration (coverage and/or disturbance)*

-OBType (Obscuration)

*If obscuration is present, indicate type NB: SALIENCE = VISIBILITY*

-enter code

1 Natural
2 Human Action

## C.2 Remains Table

-RemainsID

*Used to identify an individual set of remains*

-enter unique number to identify the set of remains

-GraveID

-enter appropriate GraveID number

-Sex

*Estimated or known biological sex of the individual*

-enter code

1 Male
2 Female
3 Undetermined

-Status

*The military or civilian status of the individual*

-enter code

1 Military
2 Civilian
3 Undetermined

-TMB (General terminology regarding location)

*Used when the remains are located in a mass grave*

-enter code

1 Top
2 Middle
3 Bottom

-RCL (General terminology regarding location)

*Used when the remains are located in a mass grave*

-enter code

1 Right
2 Centre
3 Left

-Orientation

*The orientation (polar direction) of the remains (the direction the head lies in relation to the line between the skull and the centre of the pelvis (Heizer 1958: 65) or the direction the body is facing (Sprague 1968: 482)) within the grave in relation to magnetic north (the cranium or torso being the point of origin)*

-enter in degrees (0.0 = Unknown orientation; 360.0 = North)

-OrientRange

*The range the orientation (above) of the grave is directed in relation to magnetic north*

-enter range

1 1-45°
2 46-90°
3 91-135°
4 136-180°
5 181-225°
6 226-270°
7 271-315°
8 316-360°

-Date

*Date or time period of interment using the dating and coding system (see above)*

-enter code

-Articulation

*Level of the articulation (bones in the correct position and in conjunction with the correct anatomical element(s)) of the remains (based on the percentage of the remains present) using the following coding system*

-enter code

1 1-25%
2 26-50%
3 51-75%
4 76-100%

-ContainerID

*Type of container associated with individual (if applicable)*

-enter code

2 Blanket
3 Shroud
4 Coffin
5 Body Bag
6 Other
7 Plastic Bag

-Age

*Estimated or known age of the individual using the following categories and coding system*

-enter code

| | |
|---|---|
| 0.0 | 0 - unknown |
| 110.0 | 1 month – 6 years |
| 120.0 | 7 –12 years |
| 130.0 | 13-19 years |
| 210.0 | 20 – 29 years |
| 220.0 | 30 – 39 years |
| 310.0 | 40 – 49 years |
| 510.0 | 50 – 59 years |
| 520.0 | 60 – 69 years |
| 530.0 | 70 – 79 years |
| 540.0 | 80 – 89 years |
| 100.0 | ≦ 18 years |
| 200.0 | 19 – 35 years |
| 250.0 | 25 – 45 years |
| 300.0 | 35 – 50 years |
| 400.0 | ≦ 50 years |
| 500.0 | ≧ 50 years |

-CoDID (Cause of Death)

*Determined or estimated cause of death*

-enter code

| | |
|---|---|
| 1 | Combat Related |
| 2 | Extra-judicial/intent |
| 3 | Sickness/Malnutrition |
| 4 | Natural |

-ArmID

*The upper limb's physical position within the grave in relation to the body*

-enter code

| | |
|---|---|
| 1 | Side |
| 2 | In/On Front |
| 3 | Behind |
| 4 | Above Head |
| 5 | Outstretched |
| 6 | Flexed |
| 7 | Undetermined |

-HeadID

*The head's position/direction within the grave*

-enter code

| | |
|---|---|
| 1 | Supine |
| 2 | Prone |
| 3 | Face Left |
| 4 | Face Right |
| 5 | Face Down |
| 6 | Face Up |
| 7 | Undetermined |

-PositionID

*The body's overall physical position within the grave*

-enter code

2 Prone
3 Supine
4 Extended-Right
5 Extended-Left
6 Crouched
7 Flexed
8 Flexed-Right
9 Flexed-Left
10 Unpattern/disarticulated

-Mutilation Presence

*Location (if applicable) of trauma (defacement)*

-enter code

1 Head
2 Upper body
3 Lower body

-Commingling

*Presence or absence of commingling of remains within burial*

-enter code

1 Present
0 Absent

Presence/Absence of Ritual Markers

*Presence of absence of ritual markers with remains*

-Normative Body Position

*Presence or absence normative body positioning of remains within burial*

-enter code

1 Norm body Position
0 Not Norm Body Position

-Grave Marker

*Presence or absence of grave marker associated with burial*

-enter code

1 Present
0 Absent

-Clothing

*Presence or absence normative clothing within burial*

-enter code

1 Present
0 Absent

-Grave Goods

*Presence or absence of grave goods associated with burial*

-enter code

1 Present
0 Absent

-Miscellaneous Artefacts* **(Items not normally associated with a burial)*

*Presence or absence aberrant artefacts within burial*

-enter code

| | |
|---|---|
| 1 | Present |
| 0 | Absent |

## C.3 Artefact Table

-ArtefactID

*Used to identify artifacts in the database*

-General LocationID

*Descriptive artefact position in relation to grave*

-enter code

| | |
|---|---|
| 1 | Inside burial |
| 2 | Outside burial |
| 3 | Above burial (fill) |
| 4 | Surface |

-Grave Location

*Descriptive artefact position in the grave*

-enter code

| | | | |
|---|---|---|---|
| 1 | North | 1 | North-west |
| 2 | South | 1 | North-east |
| 3 | East | 1 | North-centre |
| 4 | West | 2 | South-west |
| 5 | Centre | 2 | South-east |
| 6 | Entire | 2 | South-centre |
| | | 3 | East-centre |
| | | 4 | West-centre |

-GenTypeID

*General Artefact Type*

-enter code

| | |
|---|---|
| 1 | Armaments, etc |
| 2 | Clothing |
| 3 | Personal Item |
| 4 | Tool/Equip |
| 5 | Stone |
| 6 | Flora |
| 7 | Fauna |
| 8 | Unidentified |
| 9 | Composite |

-RemainsID

-enter appropriate RemainsID number

-GraveID

-enter appropriate GraveID number

-CemeteryID

-enter appropriate CemeteryID number

## APPENDIX D – CODING SYSTEM AND DEFINITIONS FOR FIELDS AND ENTRIES FOR MATLAB (WITH SOM TOOLBOX)

### D.1 Data file (.data) format directions

The input data is stored in ASCII-form as a list of entries, one line being reserved for each input.

The first line of the file is reserved for status knowledge of the entries. In data files the optional items are ignored.

After the first line are the data lines, comment lines or empty lines. Each data line contains one data vector (case) and its labels. From the beginning of the line, the values of the vector components (variables) are separated by spaces (single space or tab), then labels, again separated by a space. If there are missing values in the vector, they sould be indicated with the string 'NaN'.

Comment lines start with'#'. Comment lines as well as empty lines are ignored, except if the comment line starts with '#n' or '#1'. In the former, the line should contain given labels (from Vesanto et al. (2000: 58)).

### D.2 Field definitions and coding

-RemainsID

*Used to identify an individual set of remains*

-enter unique number to identify the set of remains

-Status

*The military or civilian status of the individual*

-enter code

1 Civilian
0 Not Civilian/Undetermined

-ContainerID

*Presence or Absence of normative container associated with individual*

-enter code

1 Present
0 Absent

Cause of Death variables

*Cause of Death, determined or estimated - four presence/absence variables*

-Cause of Death Combat Related (CoD-CR)

*Presence or absence of determined or estimated cause of death as combat related*

-enter code

1 Present
0 Absent

-Cause of Death Extra-judicial (CoD-EJ)

*Presence or absence of determined or estimated cause of death as extra-judicial*

-enter code

1 Present
0 Absent

-Cause of Death Sickness/Disease (CoD-SD)

*Presence or absence of determined or estimated cause of death as sickness or disease*

-enter code

1 Present
0 Absent

-Cause of Death Natural (CoD-N)

*Presence or absence of determined or estimated cause of death as natural*

-enter code

1 Present
0 Absent

-Mutilation Presence (Mut)

*Presence or absence of trauma (defacement)*

-enter code

1 Present
0 Absent

-Normative Body Position (BodPos)

*Presence or absence normative body positioning of remains within burial*

-enter code

1 Norm body Position
0 Not Norm Body Position

Ritual Markers associated with remains

*Presence or absence of ritual markers with remains*

-Grave Marker (Marker)

-enter code

1 Present
0 Absent

-Clothing (Cloth)

-enter code

1 Present
0 Absent

-Grave Goods (GG)

-enter code

1 Present
0 Absent

-Miscellaneous Artefacts (Misc.)* *(Items not normally associated with a burial)*

-enter code

1 Present

0 Absent

-CemeteryType (CemType)

*The known (or hypothesized) permanency of the cemetery*

-enter code

1 Permanent

0 Temporary

-Obscuration (ObInt)

*Intentional obscuration presence or absence (possible patterns in type may appear*

-enter code

1 Present

0 Absent

-Label

*Used to identify dataset(or case number) on resulting map*

-enter data name (e.g. Spain, Balkans) or case number

**D.3 Abbreviations used as labels to identify sites and variables in MATLAB**

D.3.1 All Data

| Label | Name | Type |
|---|---|---|
| Ant | Antietam, Maryland, USA | Conflict |
| Custer | Little Big Horn Cemetery, Montana, USA | Conflict |
| Ox | Ox Hill, Virginia, USA | Conflict |
| Snake | Snake Hill, Fort Erie, Ontario | Conflict |
| Prspct | Prospect Hill, Ontario, Canada | Normative |
| Towton | Towton, Yorkshire, UK | Conflict |
| Fisher | Fishergate (St. Andrews), Yorkshire, UK | Normative |
| SpnB | Benegiles, Zamora, Spain | Conflict |
| SpnO | Olmedillo de Roa, Burgos, Spain | Conflict |
| SpnV | Vadoncondes, Burgos, Spain | Conflict |
| SpnVil | Villaviciosa, Asturias, Spain | Conflict |
| SpnNrm | Murelaga, Vizcaya, Spain | Normative |
| SpnNrm | Villanueva, Castille y Leon, Spain | Normative |
| Bosnia | Bosanski Petrovac, Republika Srpska | Conflict |
| Croat | Pakracka Poljana, Croatia | Conflict |
| SerbN | Tenkovo, Serbia | Normative |
| CroatN | Slovanski Samac, Croatia | Normative |
| BosN | Ricica, Bosnia-Hercegovina | Normative |
| Korea | Yongchu-Li District, N Korea | Conflict |
| Korea | Army Post, Kangwon Province, N Korea | Conflict |
| Korea | Kujan, P'yongan-Pukto Prov., N Korea | Conflict |
| Korea | Unsan County, N Korea | Conflict |
| Korea | Chonui, S Korea | Conflict |
| Korea | Chulwan County, S Korea | Conflict |

| Label | Name | Type |
|---|---|---|
| Korea | Snagyi-Ri Village, N Korea | Conflict |
| Korea | Kujan County, N Korea | Conflict |
| Korea | Kujan, South Pyongan Prov., N Korea | Conflict |
| Korea | Kaech'on-Si District, N Korea | Conflict |
| Skorea | Sam Jong Don Village, S Korea | Normative |
| Ynktn | Yankton, SD, USA | Normative |

D.3.2 All Conflict Data

| Label | Name | Type |
|---|---|---|
| Ant | Antietam, Maryland, USA | Conflict |
| Custer | Little Big Horn Cemetery, Montana, USA | Conflict |
| Ox | Ox Hill, Virginia, USA | Conflict |
| Snake | Snake Hill, Fort Erie, Ontario | Conflict |
| Towton | Towton, Yorkshire, UK | Conflict |
| SpnB | Benegiles, Zamora, Spain | Conflict |
| SpnO | Olmedillo de Roa, Burgos, Spain | Conflict |
| SpnV | Vadoncondes, Burgos, Spain | Conflict |
| SpnVil | Villaviciosa, Asturias, Spain | Conflict |
| Bosnia | Bosanski Petrovac, Republika Srpska | Conflict |
| Croat | Pakracka Poljana, Croatia | Conflict |
| Korea | Yongchu-Li District, N Korea | Conflict |
| Korea | Army Post, Kangwon Province, N Korea | Conflict |
| Korea | Kujan, P'yongan-Pukto Prov., N Korea | Conflict |
| Korea | Unsan County, N Korea | Conflict |
| Korea | Chonui, S Korea | Conflict |
| Korea | Chulwan County, S Korea | Conflict |
| Korea | Snagyi-Ri Village, N Korea | Conflict |
| Korea | Kujan County, N Korea | Conflict |
| Korea | Kujan, South Pyongan Prov., N Korea | Conflict |
| Korea | Kaech'on-Si District, N Korea | Conflict |

D.3.3 Spain Data

| Label | Name | Type |
|---|---|---|
| SpnB | Benegiles, Zamora, Spain | Conflict |
| SpnO | Olmedillo de Roa, Burgos, Spain | Conflict |
| SpnV | Vadoncondes, Burgos, Spain | Conflict |
| SpnVil | Villaviciosa, Asturias, Spain | Conflict |
| SpnNrm | Murelaga, Vizcaya, Spain | Normative |
| SpnNrm | Villanueva, Castille y Leon, Spain | Normative |

D.3.4 Korea Data

| Label | Name | Type |
|---|---|---|
| Korea | Yongchu-Li District, N Korea | Conflict |
| Korea | Army Post, Kangwon Province, N Korea | Conflict |
| Korea | Kujan, P'yongan-Pukto Prov., N Korea | Conflict |
| Korea | Unsan County, N Korea | Conflict |
| Korea | Chonui, S Korea | Conflict |
| Korea | Chulwan County, S Korea | Conflict |

| Label | Name | Type |
|---|---|---|
| Korea | Snagyi-Ri Village, N Korea | Conflict |
| Korea | Kujan County, N Korea | Conflict |
| Korea | Kujan, South Pyongan Prov., N Korea | Conflict |
| Korea | Kaech'on-Si District, N Korea | Conflict |
| Skorea | Sam Jong Don Village, S Korea | Normative |
| Ynktn | Yankton, SD, USA | Normative |

D.3.5 19th Century North America Data

| Label | Name | Type |
|---|---|---|
| Ant | Antietam, Maryland, USA | Conflict |
| Custer | Little Big Horn Cemetery, Montana, USA | Conflict |
| Ox | Ox Hill, Virginia, USA | Conflict |
| Snake | Snake Hill, Fort Erie, Ontario | Conflict |
| Prspct | Prospect Hill, Ontario, Canada | Normative |

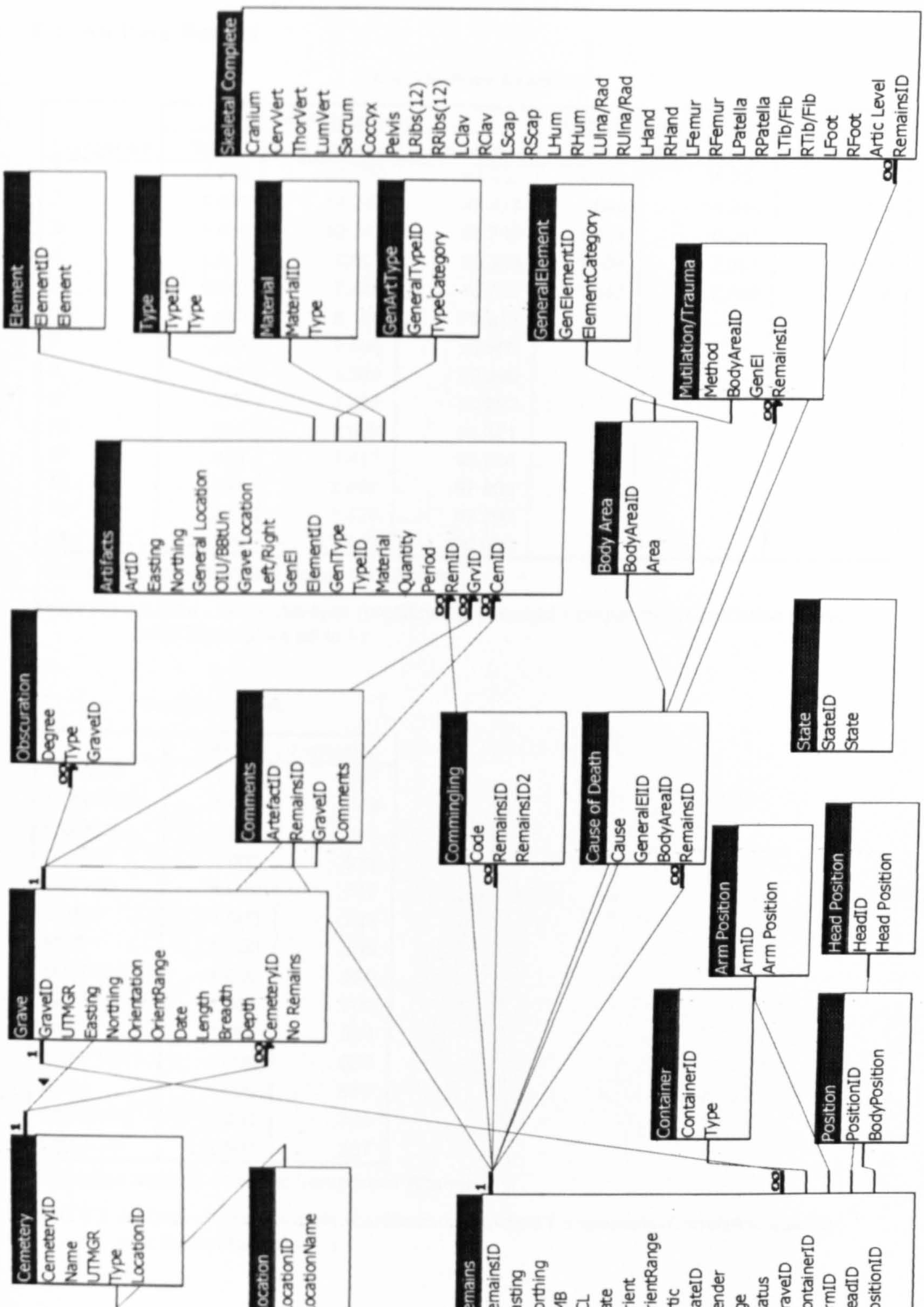
D.3.6 Medieval Data

| Label | Name | Type |
|---|---|---|
| Towton | Towton, Yorkshire, UK | Conflict |
| Fisher | Fishergate (St. Andrews), Yorkshire, UK | Normative |

D.3.7 Variables

| Label | Name |
|---|---|
| Status | Status |
| Contain | Container |
| Cloth | Clothing |
| Marker | Grave Marker |
| GG | Grave Goods |
| Misc | Miscellaneous Artefacts |
| BodPos | Body Position (normative) |
| Mut | Mutilation |
| CoD-EJ | Cause of Death-Extra-judicial |
| CoD-CR | Cause of Death-Combat related |
| CoD-SD | Cause of Death-Sickness/Disease |
| CoD-N | Cause of Death-Natural |
| CemTyp | Cemetery Type (normative) |
| ObInt | Intentional Obscuration |

# APPENDIX E – TABLES AND RELATIONSHIPS IN ACCESS DATABASE



# APPENDIX F – SPSS RESULTS

Statistical tables and figures referred to in Chapter 5: Applications and Results of Multivariate Techniques

## F.1 All Data Results

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.372 | 31.230 | 31.230 | 4.372 | 31.230 | 31.230 |
| 2 | 1.994 | 14.244 | 45.474 | 1.994 | 14.244 | 45.474 |
| 3 | 1.434 | 10.241 | 55.716 | 1.434 | 10.241 | 55.716 |
| 4 | 1.064 | 7.601 | 63.316 | 1.064 | 7.601 | 63.316 |
| 5 | 1.042 | 7.440 | 70.756 | 1.042 | 7.440 | 70.756 |
| 6 | .862 | 6.155 | 76.911 | | | |
| 7 | .783 | 5.595 | 82.506 | | | |
| 8 | .611 | 4.363 | 86.869 | | | |
| 9 | .479 | 3.423 | 90.292 | | | |
| 10 | .424 | 3.029 | 93.321 | | | |
| 11 | .338 | 2.417 | 95.738 | | | |
| 12 | .294 | 2.097 | 97.835 | | | |
| 13 | .200 | 1.426 | 99.260 | | | |
| 14 | .104 | .740 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.1** All Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .857 |
| CONTAIN | 1.000 | .748 |
| CODCR | 1.000 | .845 |
| CODEJ | 1.000 | .819 |
| CODSD | 1.000 | .847 |
| CODN | 1.000 | .732 |
| MUT | 1.000 | .539 |
| MARKER | 1.000 | .590 |
| CLOTHING | 1.000 | .730 |
| GG | 1.000 | .324 |
| BODPOSIT | 1.000 | .608 |
| MISC | 1.000 | .672 |
| CEMTYPE | 1.000 | .736 |
| OBINTNT | 1.000 | .857 |

Extraction Method: Principal Component Analysis.

**Table F.2** All Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | .573 | -.832 | .114 | .255 | .317 | -.472 | .317 | .104 | .128 | .532 | -.311 | .203 | -.114 |
| | CONTAIN | .573 | 1.000 | -.529 | -.368 | .339 | .419 | -.380 | .438 | .092 | .198 | .606 | -.474 | .519 | -.106 |
| | CODCR | -.832 | -.529 | 1.000 | -.220 | -.236 | -.278 | .445 | -.252 | -.092 | -.105 | -.421 | .316 | -.278 | .084 |
| | CODEJ | .114 | -.368 | -.220 | 1.000 | -.149 | -.176 | .146 | -.214 | .308 | -.094 | -.356 | .470 | -.538 | .026 |
| | CODSD | .255 | .339 | -.236 | -.149 | 1.000 | -.189 | -.165 | .107 | -.023 | .011 | .199 | -.194 | .194 | .019 |
| | CODN | .317 | .419 | -.278 | -.176 | -.189 | 1.000 | -.194 | .387 | .110 | .183 | .337 | -.234 | .248 | -.051 |
| | MUT | -.472 | -.380 | .445 | .146 | -.165 | -.194 | 1.000 | -.174 | -.006 | -.049 | -.337 | .291 | -.006 | .017 |
| | MARKER | .317 | .438 | -.252 | -.214 | .107 | .387 | -.174 | 1.000 | .262 | .219 | .319 | -.186 | .233 | -.075 |
| | CLOTHING | .104 | .092 | -.092 | .308 | -.023 | .110 | -.006 | .262 | 1.000 | .129 | .045 | .320 | -.172 | -.043 |
| | GG | .128 | .198 | -.105 | -.094 | .011 | .183 | -.049 | .219 | .129 | 1.000 | .147 | -.133 | .133 | -.027 |
| | BODPOSIT | .532 | .606 | -.421 | -.356 | .199 | .337 | -.337 | .319 | .045 | .147 | 1.000 | -.440 | .545 | -.055 |
| | MISC | -.311 | -.474 | .316 | .470 | -.194 | -.234 | .291 | -.186 | .320 | -.133 | -.440 | 1.000 | -.538 | .100 |
| | CEMTYPE | .203 | .519 | -.278 | -.538 | .194 | .248 | -.006 | .233 | -.172 | .133 | .545 | -.538 | 1.000 | -.205 |
| | OBINTNT | -.114 | -.106 | .084 | .026 | .019 | -.051 | .017 | -.075 | -.043 | -.027 | -.055 | .100 | -.205 | 1.000 |

**Table F.3** All Data Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
| STATUS | 1.000 | .666 | .010 | .143 | .197 | .264 | .028 | .406 | .509 | .080 | .728 | .110 | .647 | .003 |
| CONTAIN | .666 | 1.000 | .016 | .000 | .251 | .338 | .007 | .473 | .409 | .106 | .686 | .013 | .629 | .000 |
| CODCR | .010 | .016 | 1.000 | .000 | .000 | .000 | .357 | .059 | .186 | .015 | .095 | .312 | .171 | .026 |
| CODEJ | .143 | .000 | .000 | 1.000 | .000 | .000 | .149 | .016 | .205 | .000 | .031 | .361 | .026 | .018 |
| CODSD | .197 | .251 | .000 | .000 | 1.000 | .000 | .000 | .155 | .120 | .049 | .185 | .007 | .173 | .016 |
| CODN | .264 | .338 | .000 | .000 | .000 | 1.000 | .000 | .341 | .199 | .129 | .278 | .006 | .232 | .000 |
| MUT | .028 | .007 | .357 | .149 | .000 | .000 | 1.000 | .041 | .130 | .023 | .049 | .256 | .138 | .015 |
| MARKER | .406 | .473 | .059 | .016 | .155 | .341 | .041 | 1.000 | .381 | .128 | .408 | .068 | .370 | .000 |
| CLOTHING | .509 | .409 | .186 | .205 | .120 | .199 | .130 | .381 | 1.000 | .084 | .466 | .313 | .455 | .008 |
| GG | .080 | .106 | .015 | .000 | .049 | .129 | .023 | .128 | .084 | 1.000 | .085 | .000 | .076 | .000 |
| BODPOSIT | .728 | .686 | .095 | .031 | .185 | .278 | .049 | .408 | .466 | .085 | 1.000 | .066 | .751 | .007 |
| MISC | .110 | .013 | .312 | .361 | .007 | .006 | .256 | .068 | .313 | .000 | .066 | 1.000 | .085 | .031 |
| CEMTYPE | .647 | .629 | .171 | .026 | .173 | .232 | .138 | .370 | .455 | .076 | .751 | .085 | 1.000 | .000 |
| OBINTNT | .003 | .000 | .026 | .018 | .016 | .000 | .015 | .000 | .008 | .000 | .007 | .031 | .000 | 1.000 |

**Table F.4** All Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

Dendrogram using Average Linkage (Between Groups)

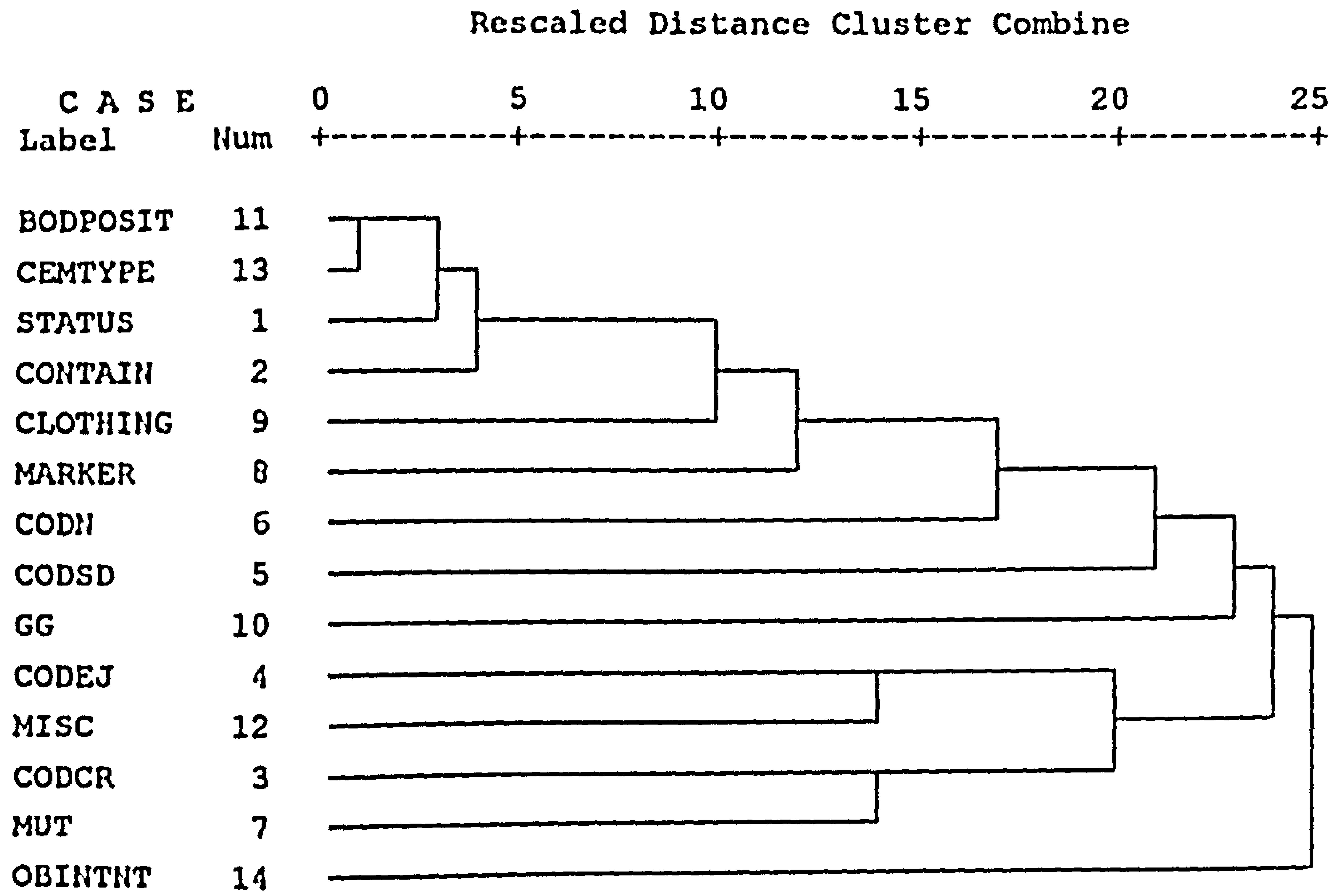



**Figure F.1** All Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine

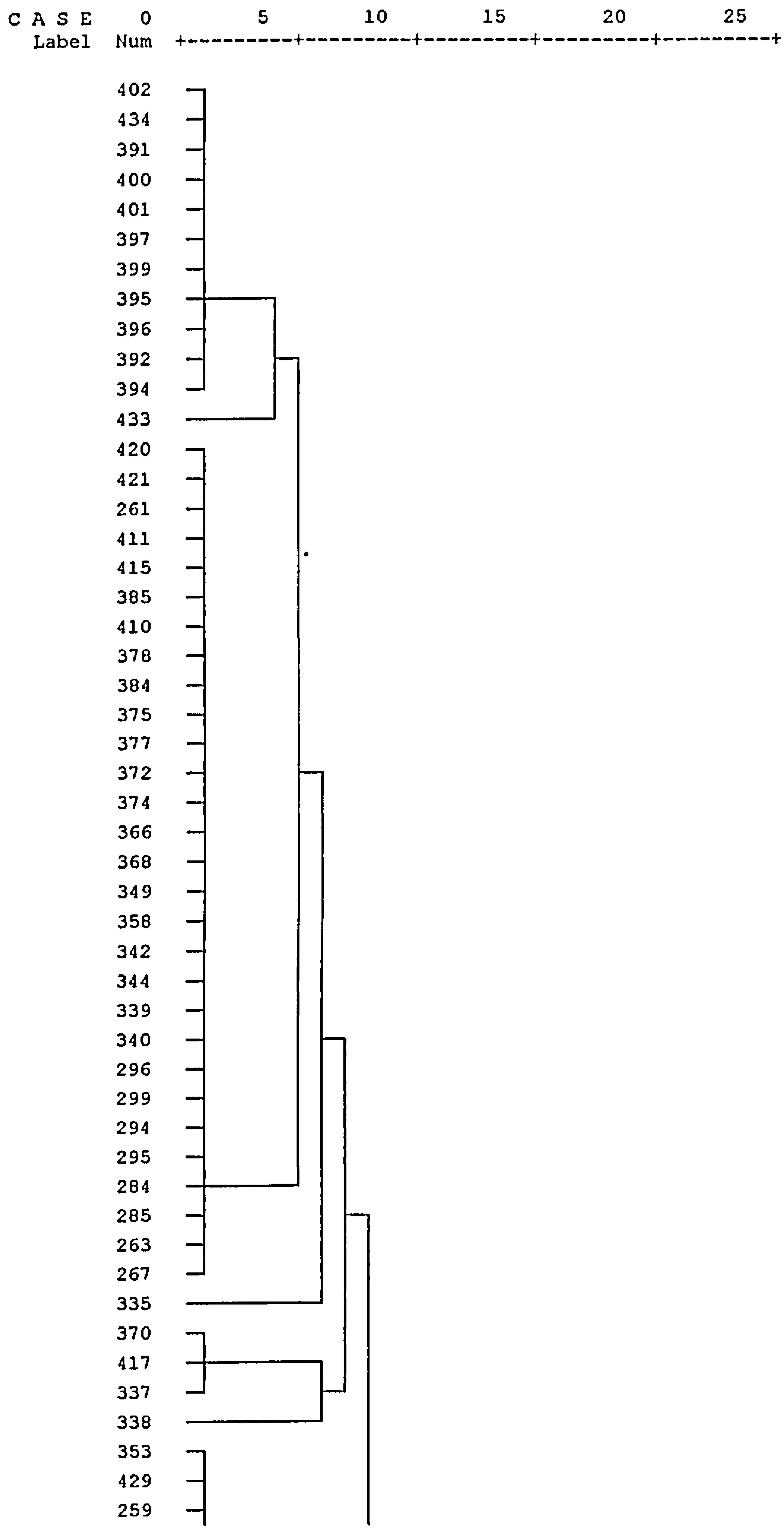



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

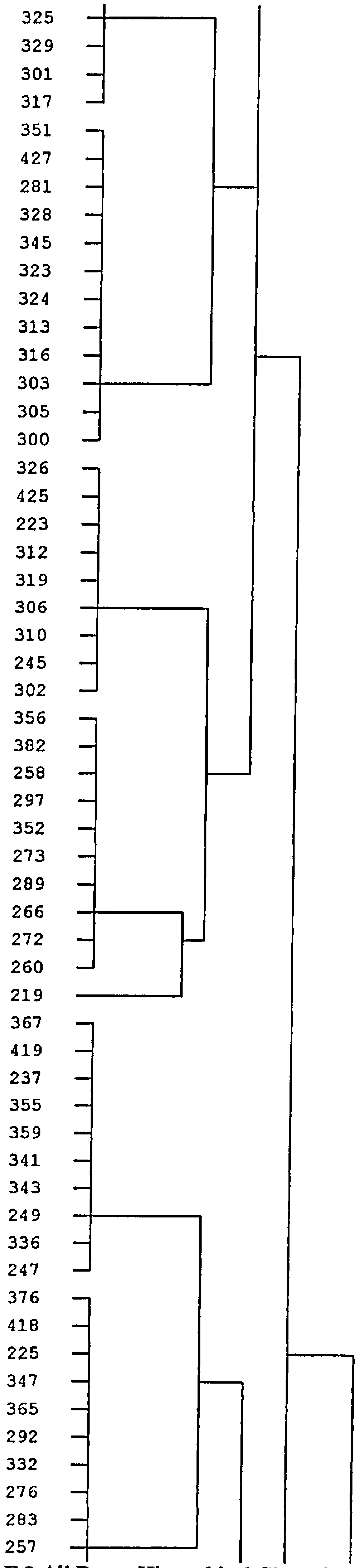



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

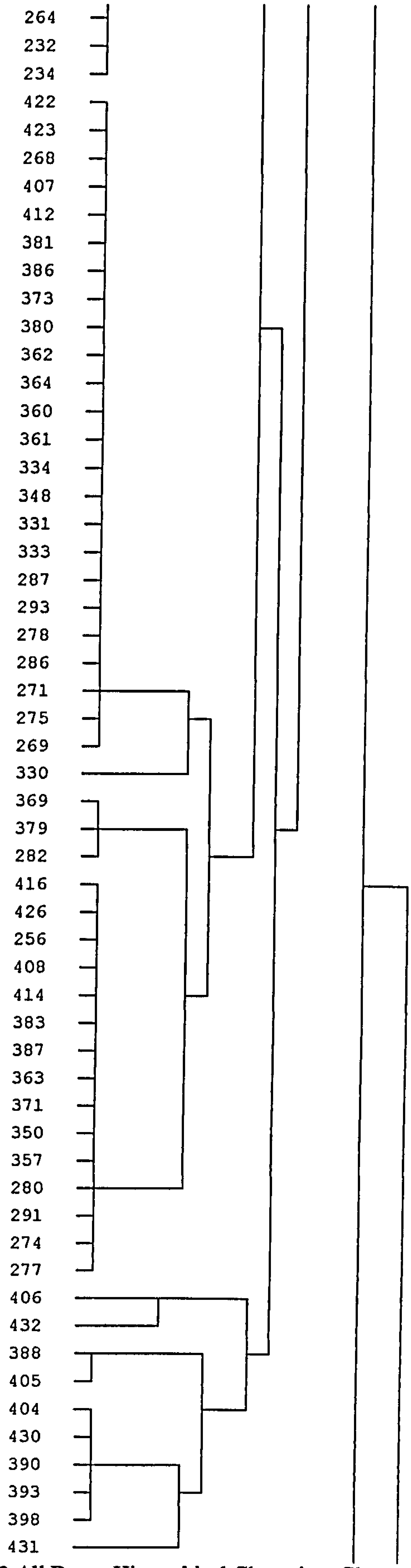



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

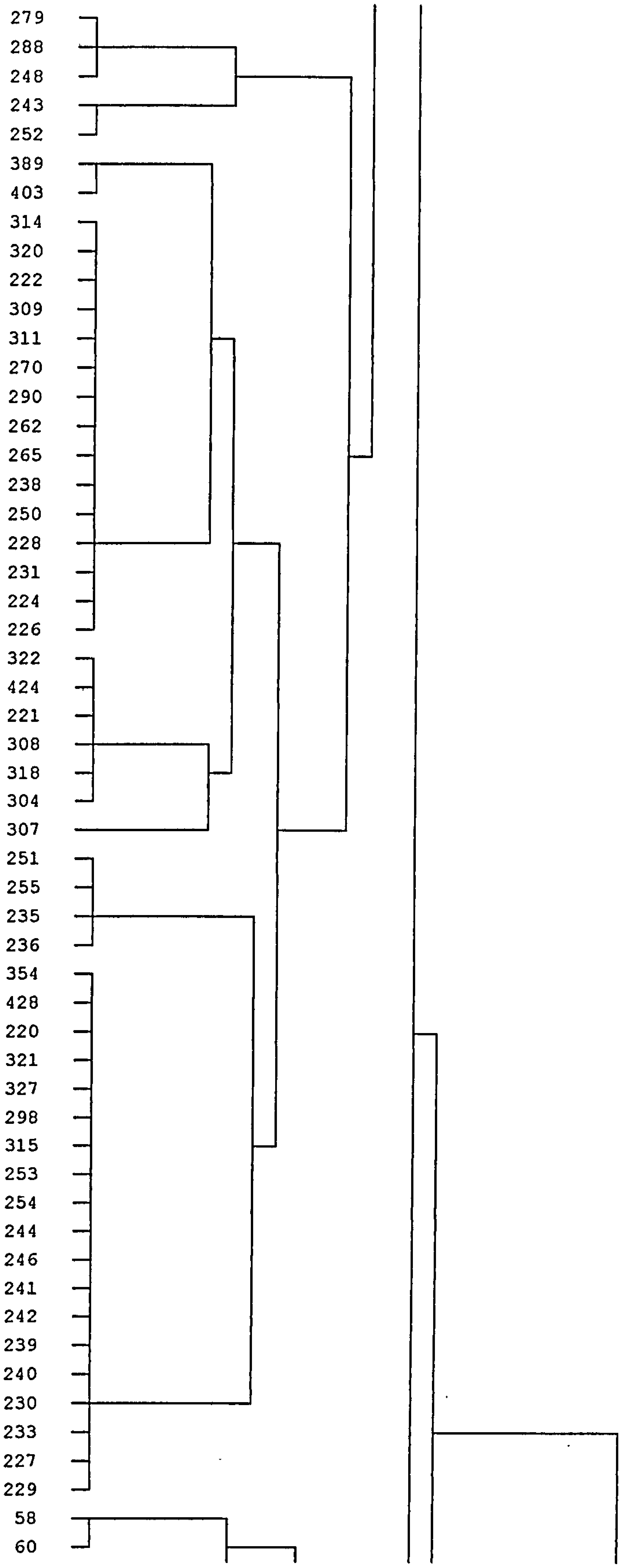



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

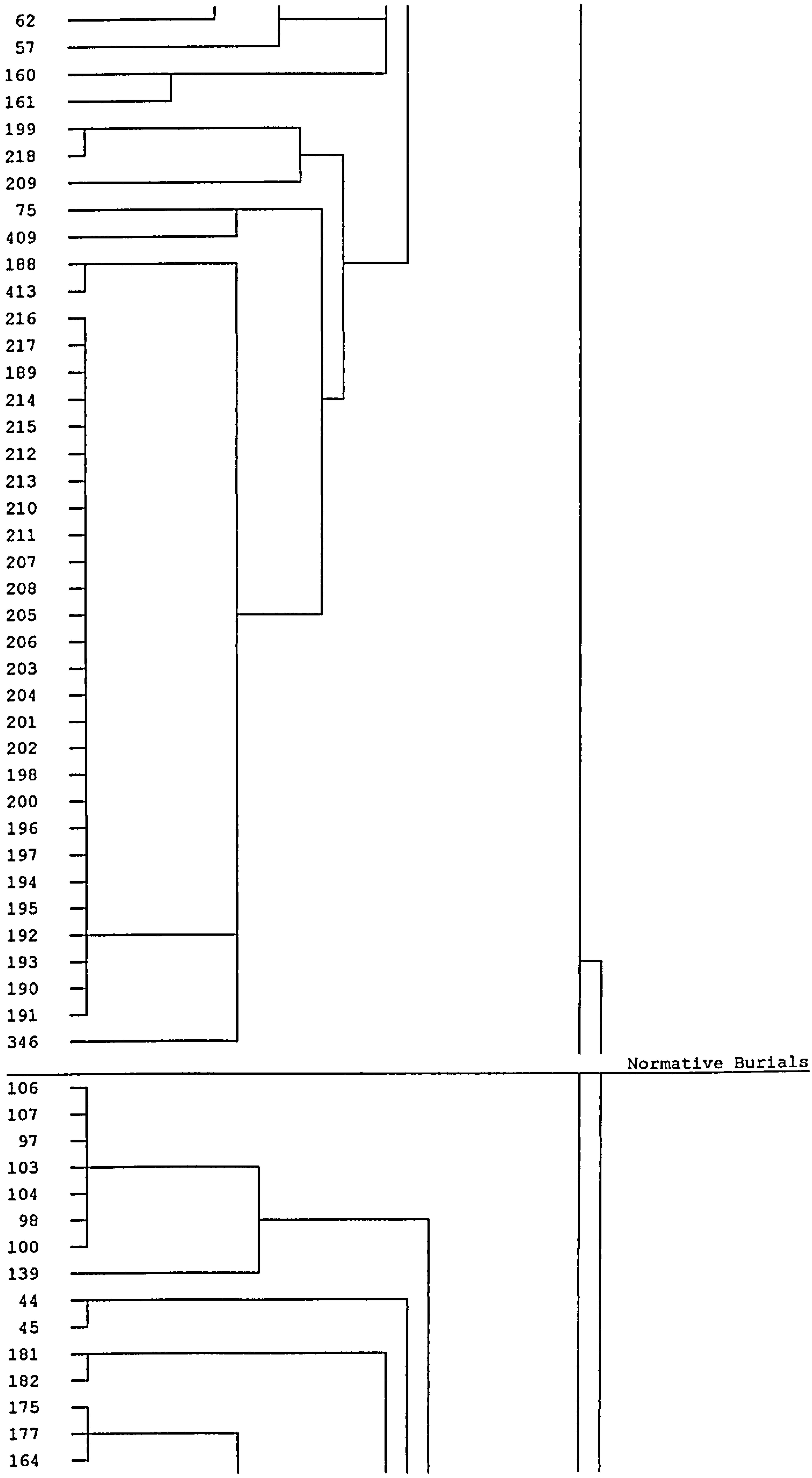



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

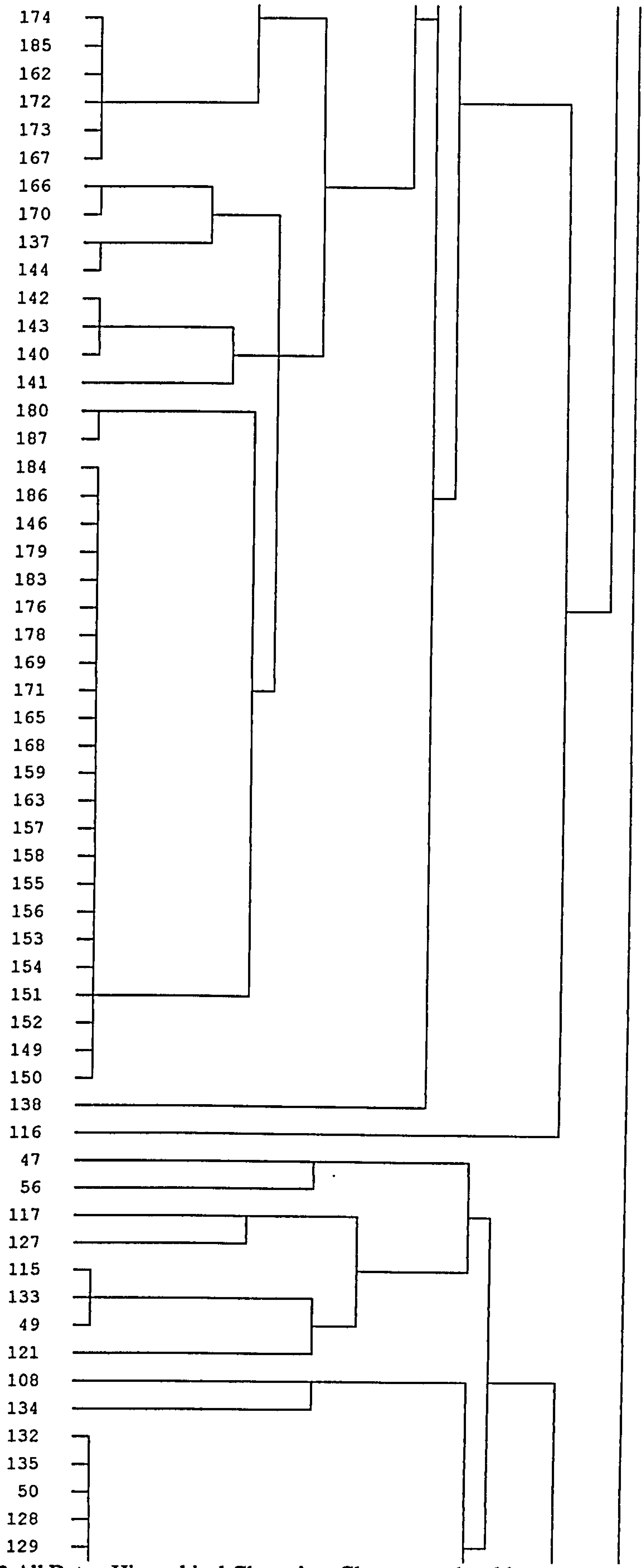


**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

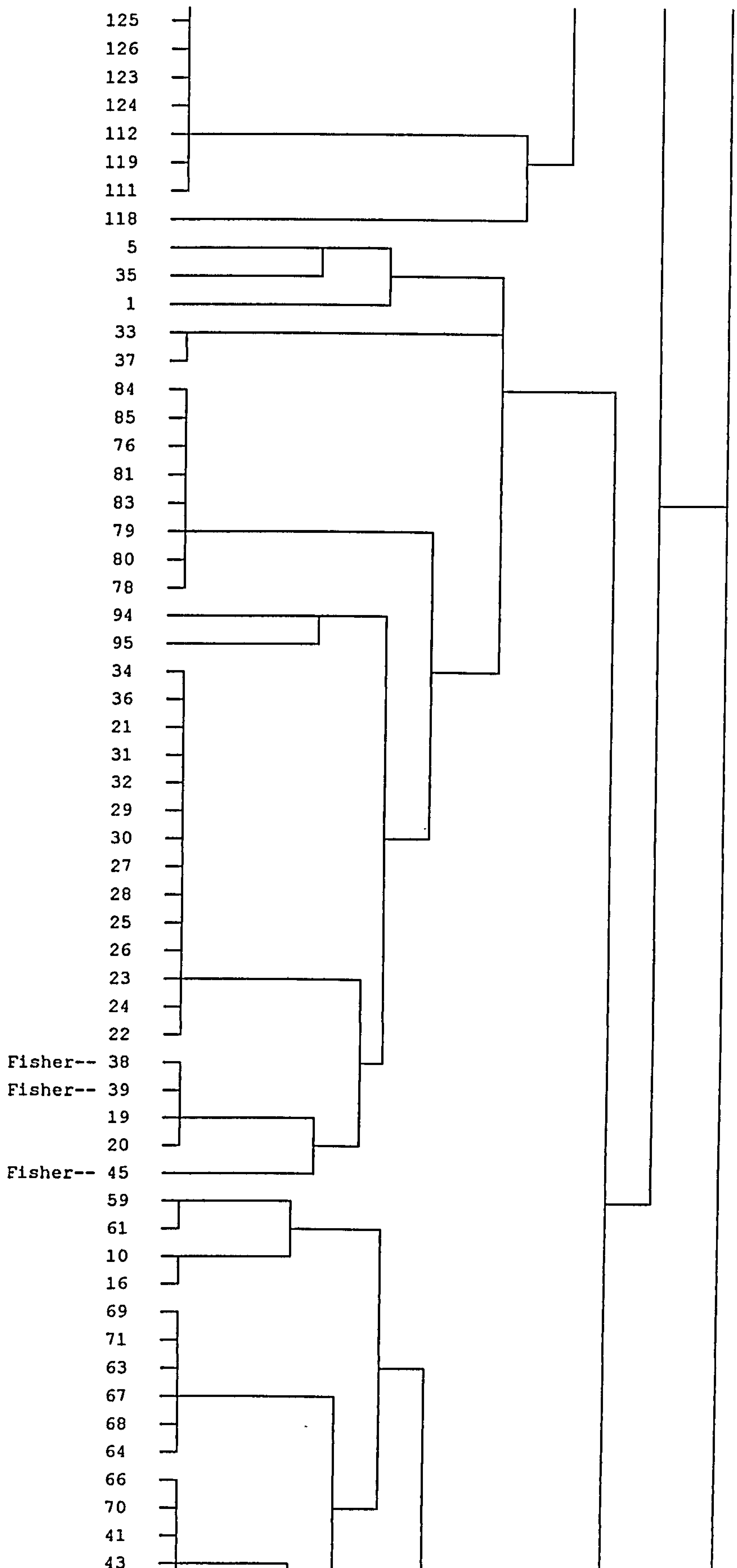



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

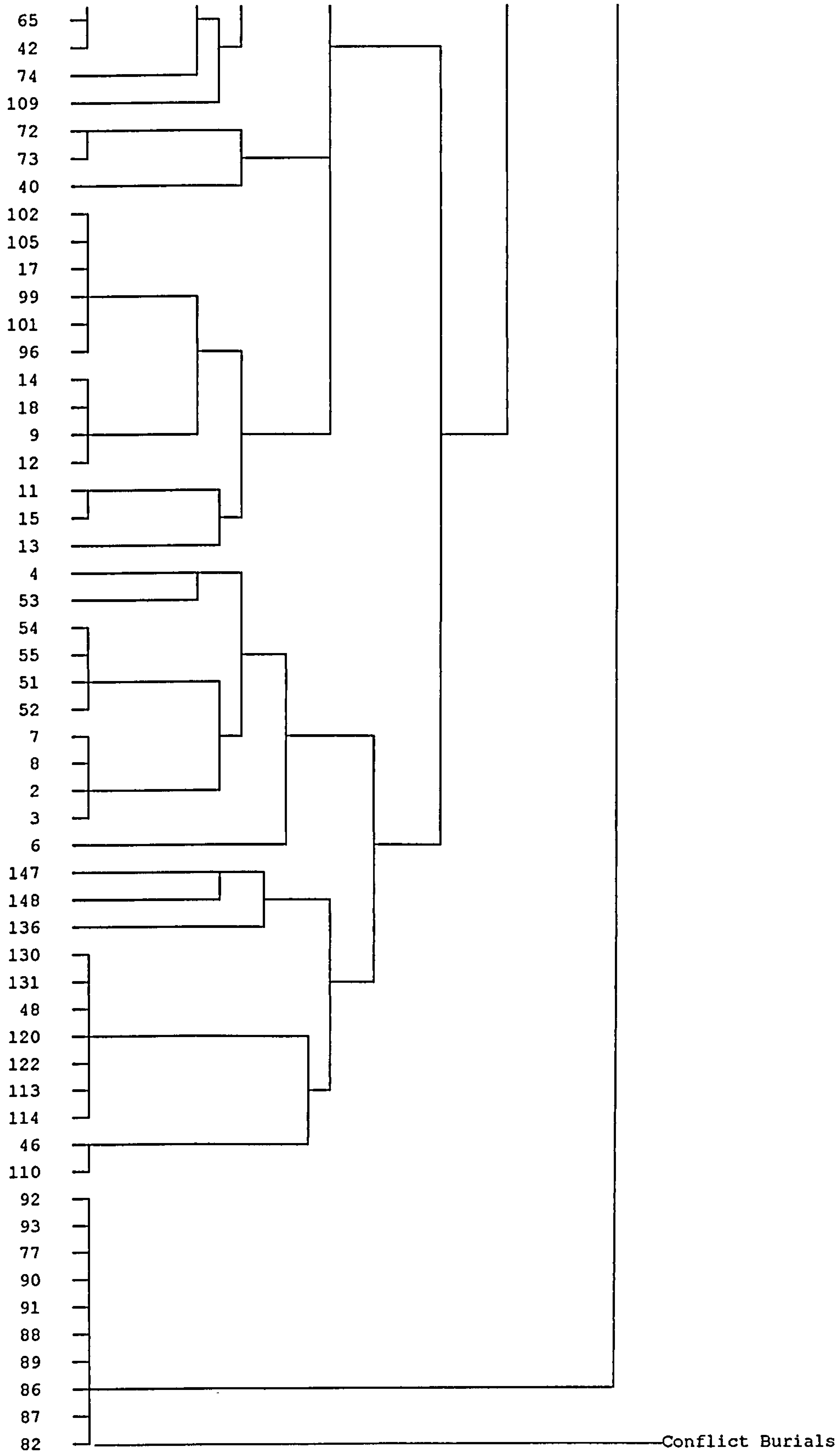



**Figure F.2** All Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| STATUS | 1 | 1 | 0 | 0 | 1 |
| CONTAIN | 1 | 1 | 0 | 0 | 0 |
| CODCR | 0 | 0 | 1 | 0 | 0 |
| CODEJ | 0 | 0 | 0 | 1 | 1 |
| CODSD | 0 | 0 | 0 | 0 | 0 |
| CODN | 0 | 0 | 0 | 0 | 0 |
| MUT | 0 | 0 | 0 | 1 | 0 |
| MARKER | 0 | 1 | 0 | 0 | 0 |
| CLOTHING | 0 | 1 | 0 | 1 | 1 |
| GG | 0 | 0 | 0 | 0 | 0 |
| BODPOSIT | 1 | 1 | 0 | 0 | 0 |
| MISC | 0 | 0 | 0 | 1 | 1 |
| CEMTYPE | 1 | 1 | 1 | 1 | 0 |
| OBINTNT | 0 | 0 | 0 | 0 | 0 |

**Table F.5** All Data - K-means Clustering: Cluster membership 5; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| STATUS | Civilian | Civilian | Military | Military | Civilian |
| CONTAIN | Yes | Yes | No | No | No |
| CODCR | No | No | Yes | No | No |
| CODEJ | No | No | No | Yes | Yes |
| CODSD | No | No | No | No | No |
| CODN | No | No | No | No | No |
| MUT | No | No | No | Yes | No |
| MARKER | No | Yes | No | No | No |
| CLOTHING | No | Yes | No | Yes | Yes |
| GG | No | No | No | No | No |
| BODPOSIT | Norm | Norm | No | No | No |
| MISC | No | No | No | Yes | Yes |
| CEMTYPE | Perm | Perm | Perm | Perm | Temp |
| OBINTNT | No | No | No | No | No |

**Table F.6** All Data - K-means Clustering: Cluster membership 5; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 105.000 |
| | 2 | 146.000 |
| | 3 | 124.000 |
| | 4 | 8.000 |
| | 5 | 51.000 |
| Valid | | 434.000 |
| Missing | | .000 |

**Table F.7** All Data - K-means Clustering: Cluster membership 5; Squared Euclidean distance

## F.2 All Conflict Data Results

**Total Variance Explained**

| Component | Initial Eigenvalues Total | Initial Eigenvalues % of Variance | Initial Eigenvalues Cumulative % | Extraction Sums of Squared Loadings Total | Extraction Sums of Squared Loadings % of Variance | Extraction Sums of Squared Loadings Cumulative % |
|---|---|---|---|---|---|---|
| 1 | 3.259 | 27.158 | 27.158 | 3.259 | 27.158 | 27.158 |
| 2 | 1.612 | 13.430 | 40.588 | 1.612 | 13.430 | 40.588 |
| 3 | 1.425 | 11.874 | 52.463 | 1.425 | 11.874 | 52.463 |
| 4 | 1.251 | 10.421 | 62.884 | 1.251 | 10.421 | 62.884 |
| 5 | 1.006 | 8.382 | 71.266 | 1.006 | 8.382 | 71.266 |
| 6 | .921 | 7.678 | 78.944 | | | |
| 7 | .739 | 6.162 | 85.106 | | | |
| 8 | .627 | 5.221 | 90.328 | | | |
| 9 | .473 | 3.945 | 94.273 | | | |
| 10 | .342 | 2.849 | 97.122 | | | |
| 11 | .189 | 1.577 | 98.699 | | | |
| 12 | .156 | 1.301 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.8** All Conflict Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .829 |
| CONTAIN | 1.000 | .594 |
| CODCR | 1.000 | .774 |
| CODEJ | 1.000 | .872 |
| CODSD | 1.000 | .713 |
| MUT | 1.000 | .764 |
| MARKER | 1.000 | .573 |
| CLOTHING | 1.000 | .779 |
| GG | 1.000 | .289 |
| BODPOSIT | 1.000 | .651 |
| MISC | 1.000 | .675 |
| CEMTYPE | 1.000 | .727 |
| OBINTNT | 1.000 | .720 |

Extraction Method: Principal Component Analysis.

**Table F.9** All Conflict Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODEJ | CODSD | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | -.141 | -.672 | .785 | -.046 | -.194 | -.073 | .445 | -.046 | -.036 | .277 | -.532 | -.029 |
| | CONTAIN | -.141 | 1.000 | -.016 | -.145 | -.017 | -.049 | -.073 | .163 | -.017 | .345 | -.128 | .234 | -.038 |
| | CODCR | -.672 | -.016 | 1.000 | -.766 | -.089 | .171 | .152 | -.315 | .062 | .105 | -.118 | .211 | .003 |
| | CODEJ | .785 | -.145 | -.766 | 1.000 | -.047 | -.054 | -.080 | .457 | -.047 | -.077 | .298 | -.380 | -.033 |
| | CODSD | -.046 | -.017 | -.089 | -.047 | 1.000 | -.051 | -.024 | .053 | -.005 | -.042 | .074 | -.072 | .442 |
| | MUT | -.194 | -.049 | .171 | -.054 | -.051 | 1.000 | .101 | -.050 | .107 | -.060 | .055 | .381 | -.044 |
| | MARKER | -.073 | -.073 | .152 | -.080 | -.024 | .101 | 1.000 | .110 | -.024 | -.092 | .205 | -.085 | -.054 |
| | CLOTHING | .445 | .163 | -.315 | .457 | .053 | -.050 | .110 | 1.000 | -.104 | .268 | .489 | -.204 | -.092 |
| | GG | -.046 | -.017 | .062 | -.047 | -.005 | .107 | -.024 | -.104 | 1.000 | -.042 | -.075 | .076 | -.012 |
| | BODPOSIT | -.036 | .345 | .105 | -.077 | -.042 | -.060 | -.092 | .268 | -.042 | 1.000 | -.029 | .220 | .063 |
| | MISC | .277 | -.128 | -.118 | .298 | .074 | .055 | .205 | .489 | -.075 | -.029 | 1.000 | -.279 | .033 |
| | CEMTYPE | -.532 | .234 | .211 | -.380 | -.072 | .381 | -.085 | -.204 | .076 | .220 | -.279 | 1.000 | -.163 |
| | OBINTNT | -.029 | -.038 | .003 | -.033 | .442 | -.044 | -.054 | -.092 | -.012 | .063 | .033 | -.163 | 1.000 |

**Table F.10** All Conflict Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODEJ | CODSD | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
| STATUS | 1.000 | .000 | .019 | .733 | .000 | .089 | .046 | .421 | .000 | .131 | .349 | .022 | .018 |
| CONTAIN | .000 | 1.000 | .045 | .000 | .000 | .030 | .000 | .074 | .000 | .178 | .020 | .101 | .000 |
| CODCR | .019 | .045 | 1.000 | .000 | .000 | .336 | .126 | .339 | .009 | .246 | .325 | .459 | .027 |
| CODEJ | .733 | .000 | .000 | 1.000 | .000 | .155 | .045 | .438 | .000 | .115 | .368 | .076 | .018 |
| CODSD | .000 | .000 | .000 | .000 | 1.000 | .000 | .000 | .008 | .000 | .000 | .011 | .000 | .200 |
| MUT | .089 | .030 | .336 | .155 | .000 | 1.000 | .118 | .259 | .017 | .132 | .269 | .437 | .016 |
| MARKER | .046 | .000 | .126 | .045 | .000 | .118 | 1.000 | .113 | .000 | .034 | .147 | .060 | .000 |
| CLOTHING | .421 | .074 | .339 | .438 | .008 | .259 | .113 | 1.000 | .000 | .310 | .626 | .313 | .016 |
| GG | .000 | .000 | .009 | .000 | .000 | .017 | .000 | .000 | 1.000 | .000 | .000 | .011 | .000 |
| BODPOSIT | .131 | .178 | .246 | .115 | .000 | .132 | .034 | .310 | .000 | 1.000 | .183 | .291 | .043 |
| MISC | .349 | .020 | .325 | .368 | .011 | .269 | .147 | .626 | .000 | .183 | 1.000 | .215 | .032 |
| CEMTYPE | .022 | .101 | .459 | .076 | .000 | .437 | .060 | .313 | .011 | .291 | .215 | 1.000 | .000 |
| OBINTNT | .018 | .000 | .027 | .018 | .200 | .016 | .000 | .016 | .000 | .043 | .032 | .000 | 1.000 |

**Table F.11** All Conflict Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine

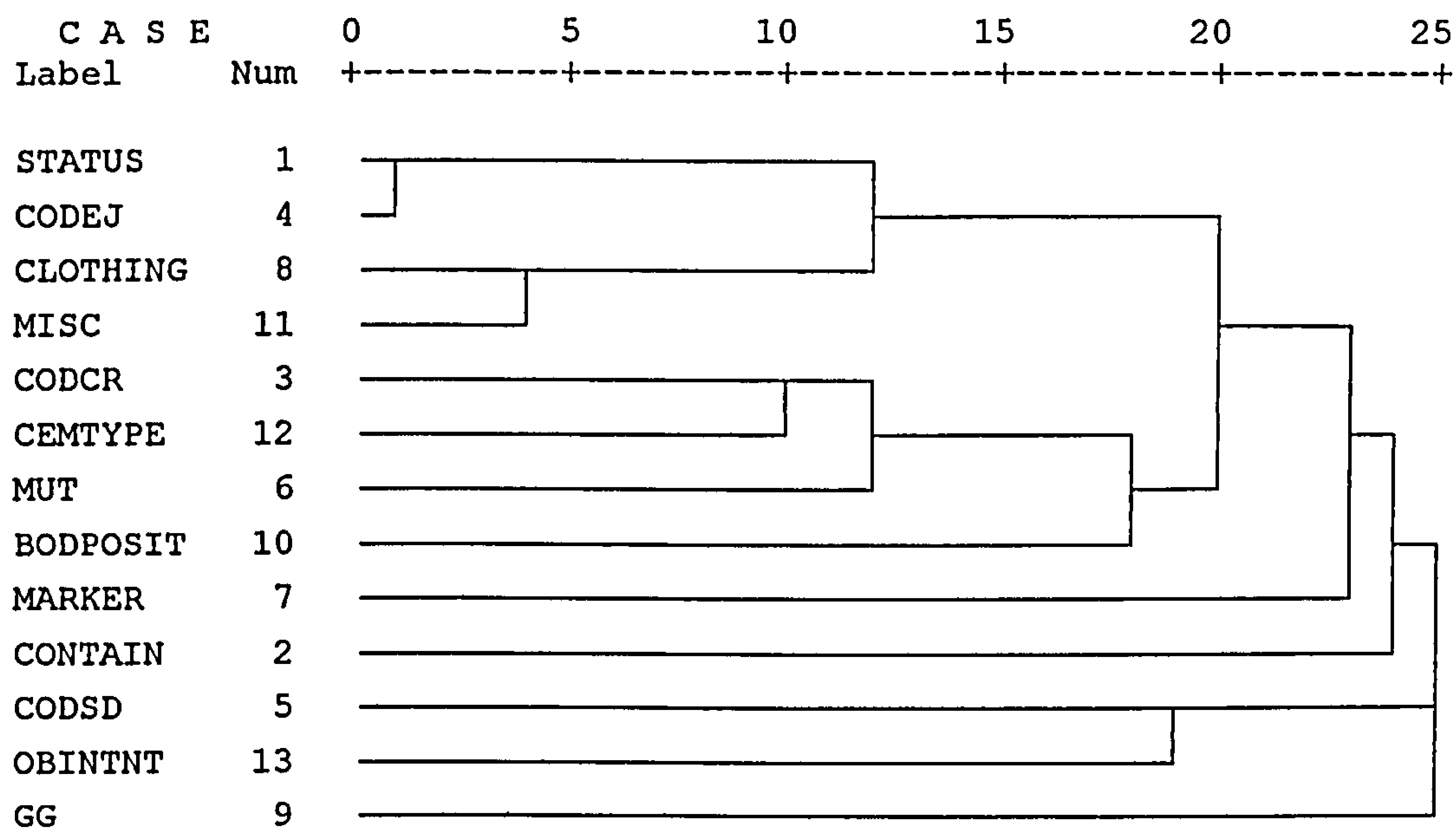



**Figure F.3** All Conflict Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

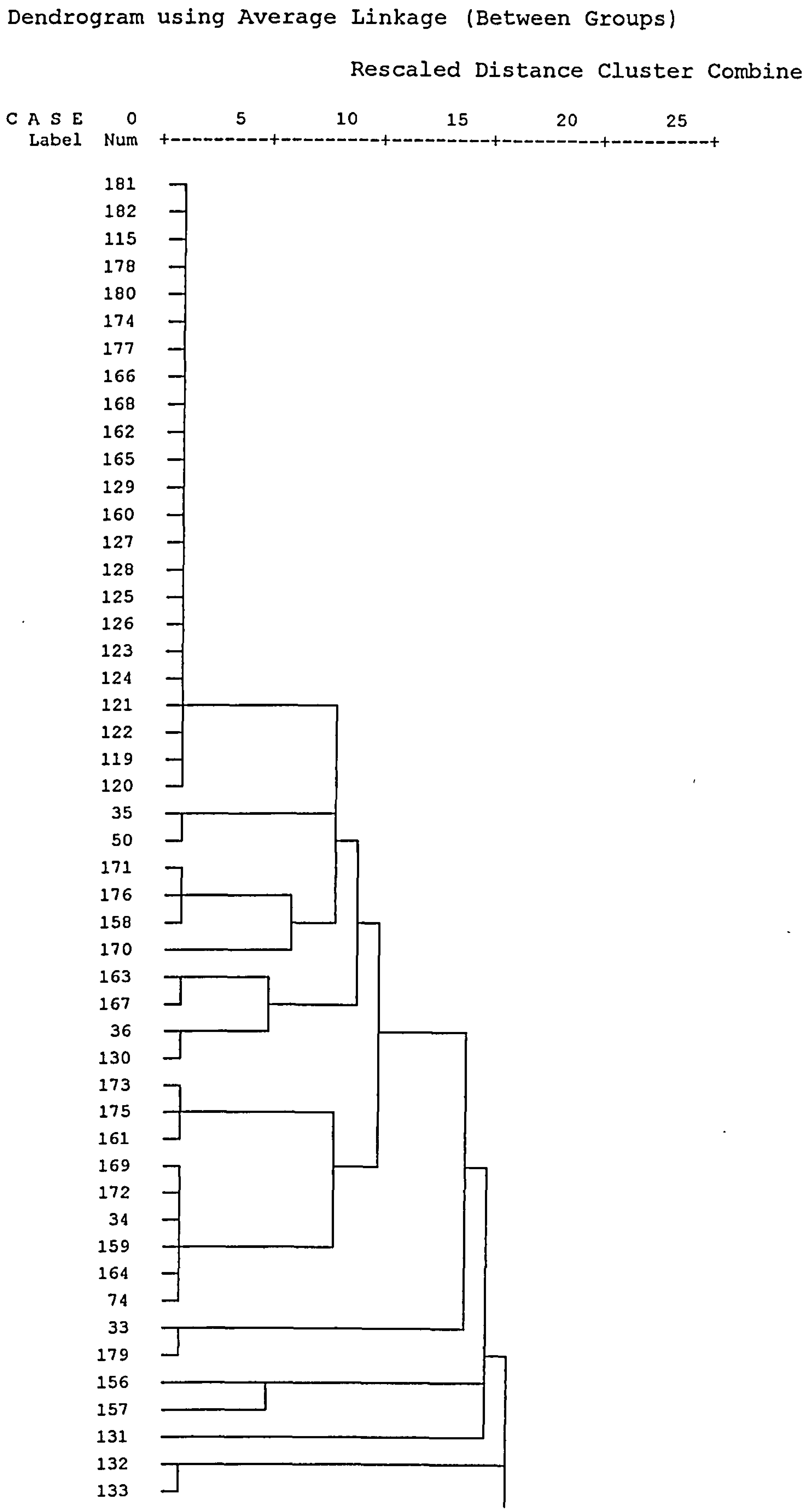



**Figure F.4** All Conflict Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

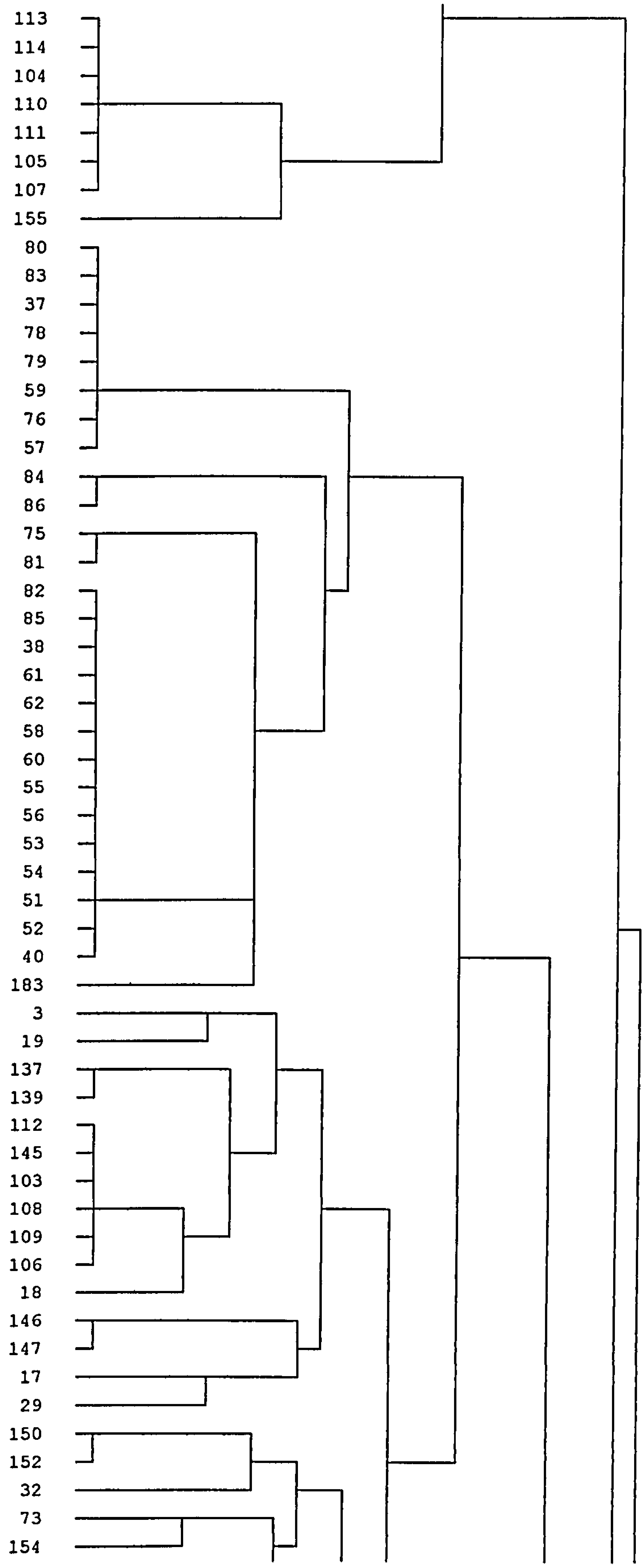



**Figure F.4** All Conflict Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

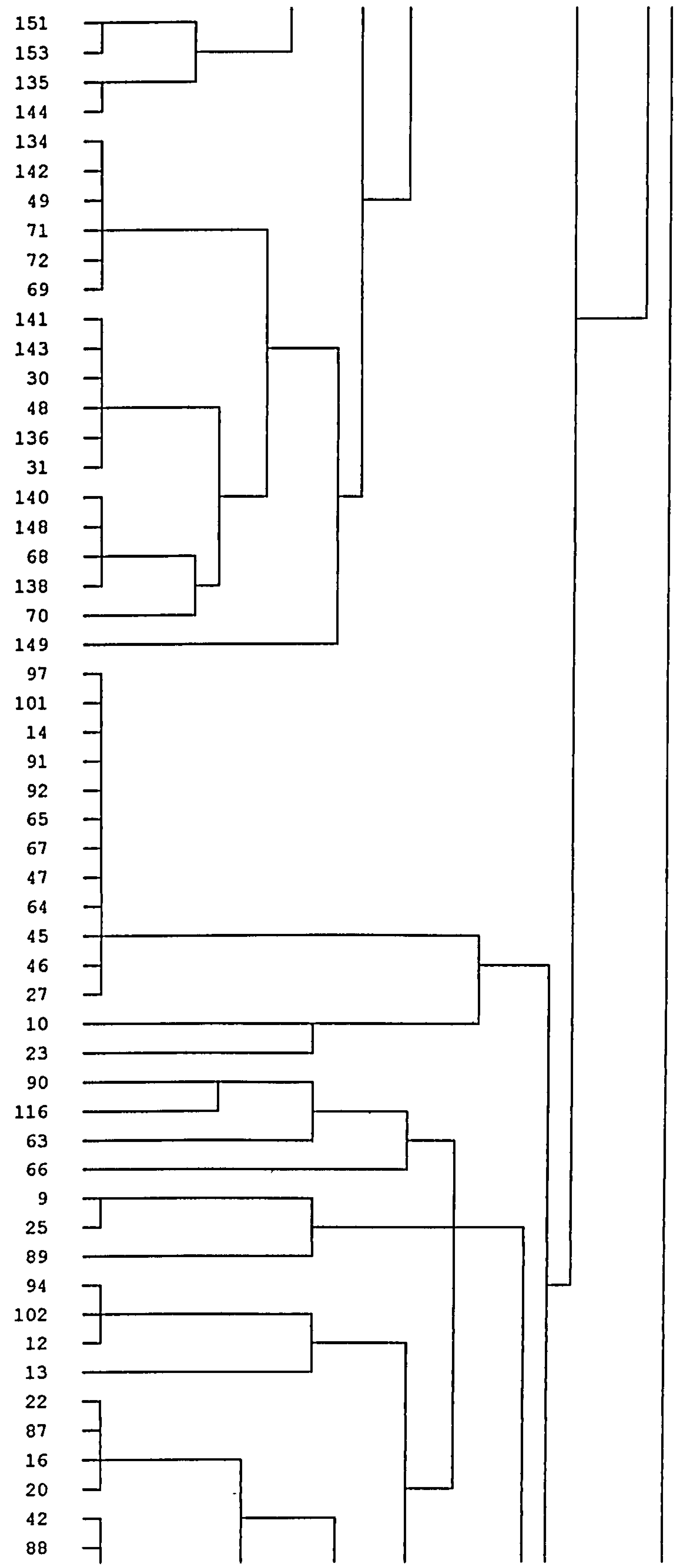



**Figure F.4** All Conflict Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

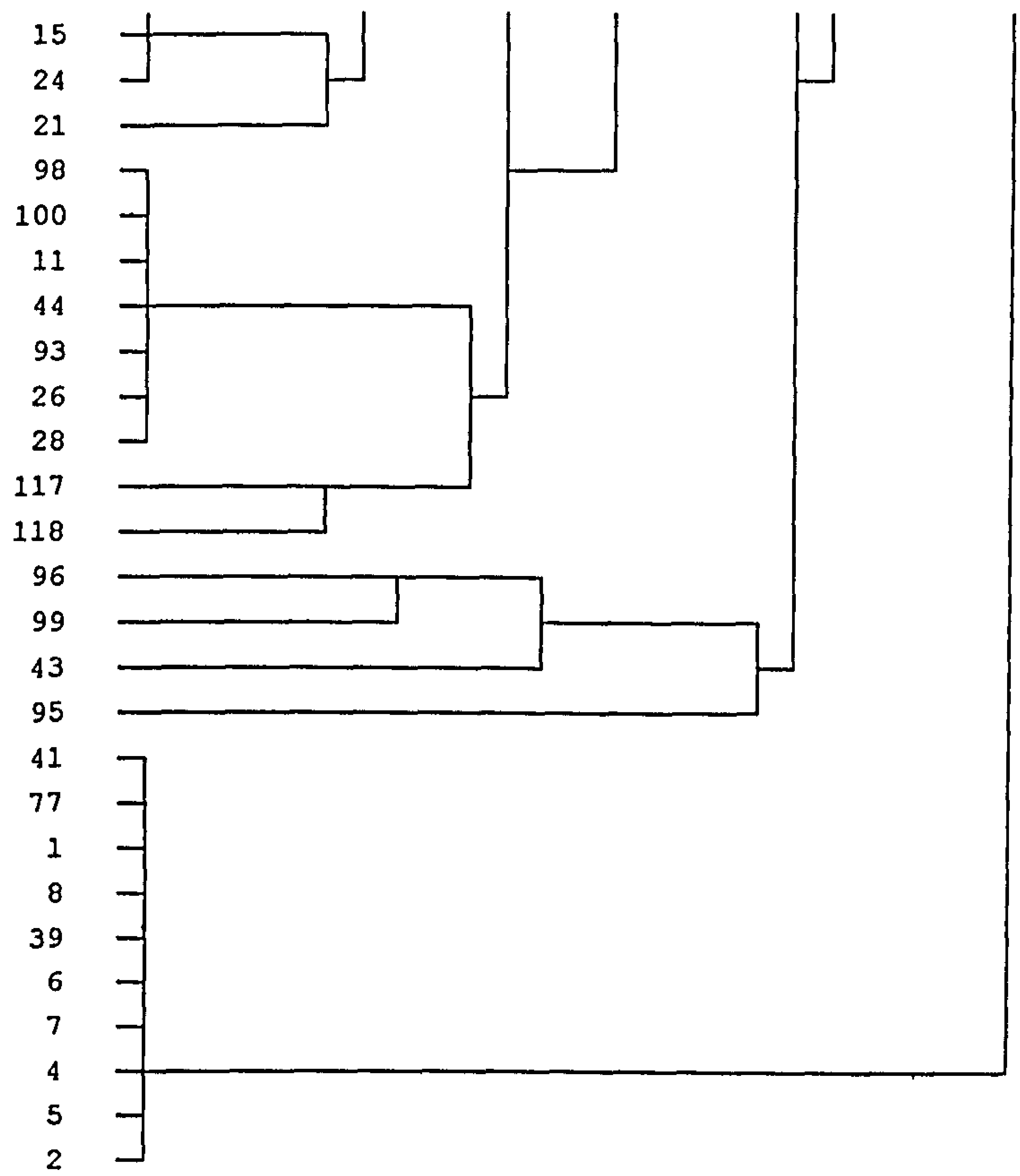



**Figure F.4** All Conflict Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | 0 | 1 | 0 |
| CONTAIN | 0 | 0 | 0 |
| CODCR | 1 | 0 | 1 |
| CODEJ | 0 | 1 | 0 |
| CODSD | 0 | 0 | 0 |
| MUT | 0 | 0 | 0 |
| MARKER | 0 | 0 | 0 |
| CLOTHING | 1 | 1 | 0 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 1 | 0 | 0 |
| MISC | 1 | 1 | 0 |
| CEMTYPE | 1 | 0 | 1 |
| OBINTNT | 0 | 0 | 0 |

**Table F.12** All Conflict Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | Military | Civilian | Military |
| CONTAIN | None | None | None |
| CODCR | Yes | No | Yes |
| CODEJ | No | Yes | No |
| CODSD | No | No | No |
| MUT | No | No | No |
| MARKER | No | No | No |
| CLOTHING | Yes | Yes | No |
| GG | No | No | No |
| BODPOSIT | Norm | No | No |
| MISC | Yes | Yes | No |
| CEMTYPE | Norm | Temp | Norm |
| OBINTNT | No | No | No |

**Table F.13** All Conflict Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 32.000 |
| | 2 | 60.000 |
| | 3 | 91.000 |
| Valid | | 183.000 |
| Missing | | .000 |

**Table F.14** All Conflict Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

## Individual Site Data Results

## F.3 Spain:

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.132 | 45.916 | 45.916 | 4.132 | 45.916 | 45.916 |
| 2 | 1.374 | 15.262 | 61.178 | 1.374 | 15.262 | 61.178 |
| 3 | .928 | 10.312 | 71.490 | | | |
| 4 | .804 | 8.933 | 80.422 | | | |
| 5 | .488 | 5.426 | 85.849 | | | |
| 6 | .436 | 4.848 | 90.697 | | | |
| 7 | .341 | 3.788 | 94.485 | | | |
| 8 | .338 | 3.755 | 98.239 | | | |
| 9 | .158 | 1.761 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.15** Spain Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| CONTAIN | 1.000 | .801 |
| CODEJ | 1.000 | .776 |
| CODSD | 1.000 | .744 |
| CODN | 1.000 | .687 |
| MUT | 1.000 | .156 |
| MARKER | 1.000 | .625 |
| GG | 1.000 | .414 |
| BODPOSIT | 1.000 | .718 |
| MISC | 1.000 | .557 |
| CEMTYPE | 1.000 | .877 |

Extraction Method: Principal Component Analysis.

**Table F.16** Spain Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues sèt to 1)

**Proximity Matrix**

| Case | Matrix File Input | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | STATUS | CONTAIN | CODCR | CODEJ | CODSD | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
| STATUS | 1.000 | .000 | .019 | .733 | .000 | .089 | .046 | .421 | .000 | .131 | .349 | .022 | .018 |
| CONTAIN | .000 | 1.000 | .045 | .000 | .000 | .030 | .000 | .074 | .000 | .178 | .020 | .101 | .000 |
| CODCR | .019 | .045 | 1.000 | .000 | .000 | .336 | .126 | .339 | .009 | .246 | .325 | .459 | .027 |
| CODEJ | .733 | .000 | .000 | 1.000 | .000 | .155 | .045 | .438 | .000 | .115 | .368 | .076 | .018 |
| CODSD | .000 | .000 | .000 | .000 | 1.000 | .000 | .000 | .008 | .000 | .000 | .011 | .000 | .200 |
| MUT | .089 | .030 | .336 | .155 | .000 | 1.000 | .118 | .259 | .017 | .132 | .269 | .437 | .016 |
| MARKER | .046 | .000 | .126 | .045 | .000 | .118 | 1.000 | .113 | .000 | .034 | .147 | .060 | .000 |
| CLOTHING | .421 | .074 | .339 | .438 | .008 | .259 | .113 | 1.000 | .000 | .310 | .626 | .313 | .016 |
| GG | .000 | .000 | .009 | .000 | .000 | .017 | .000 | .000 | 1.000 | .000 | .000 | .011 | .000 |
| BODPOSIT | .131 | .178 | .246 | .115 | .000 | .132 | .034 | .310 | .000 | 1.000 | .183 | .291 | .043 |
| MISC | .349 | .020 | .325 | .368 | .011 | .269 | .147 | .626 | .000 | .183 | 1.000 | .215 | .032 |
| CEMTYPE | .022 | .101 | .459 | .076 | .000 | .437 | .060 | .313 | .011 | .291 | .215 | 1.000 | .000 |
| OBINTNT | .018 | .000 | .027 | .018 | .200 | .016 | .000 | .016 | .000 | .043 | .032 | .000 | 1.000 |

**Table F.11** All Conflict Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

**Correlation Matrix**

| | | CONTAIN | CODEJ | CODSD | CODN | MUT | MARKER | GG | BODPOSIT | MISC | CEMTYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | CONTAIN | 1.000 | -.813 | .320 | .456 | -.285 | .614 | .133 | .720 | -.612 | .838 |
| | CODEJ | -.813 | 1.000 | -.390 | -.432 | .350 | -.611 | -.109 | -.642 | .624 | -.792 |
| | CODSD | .320 | -.390 | 1.000 | -.214 | -.137 | .253 | .278 | .346 | -.294 | .402 |
| | CODN | .456 | -.432 | -.214 | 1.000 | -.151 | .397 | -.059 | .383 | -.325 | .445 |
| | MUT | -.285 | .350 | -.137 | -.151 | 1.000 | -.172 | -.038 | -.289 | .353 | -.236 |
| | MARKER | .614 | -.611 | .253 | .397 | -.172 | 1.000 | .137 | .638 | -.466 | .813 |
| | GG | .133 | -.109 | .278 | -.059 | -.038 | .137 | 1.000 | .096 | -.082 | .112 |
| | BODPOSIT | .720 | -.642 | .346 | .383 | -.289 | .638 | .096 | 1.000 | -.588 | .799 |
| | MISC | -.612 | .624 | -.294 | -.325 | .353 | -.466 | -.082 | -.588 | 1.000 | -.602 |
| | CEMTYPE | .838 | -.792 | .402 | .445 | -.236 | .813 | .112 | .799 | -.602 | 1.000 |

**Table F.17** Spain Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

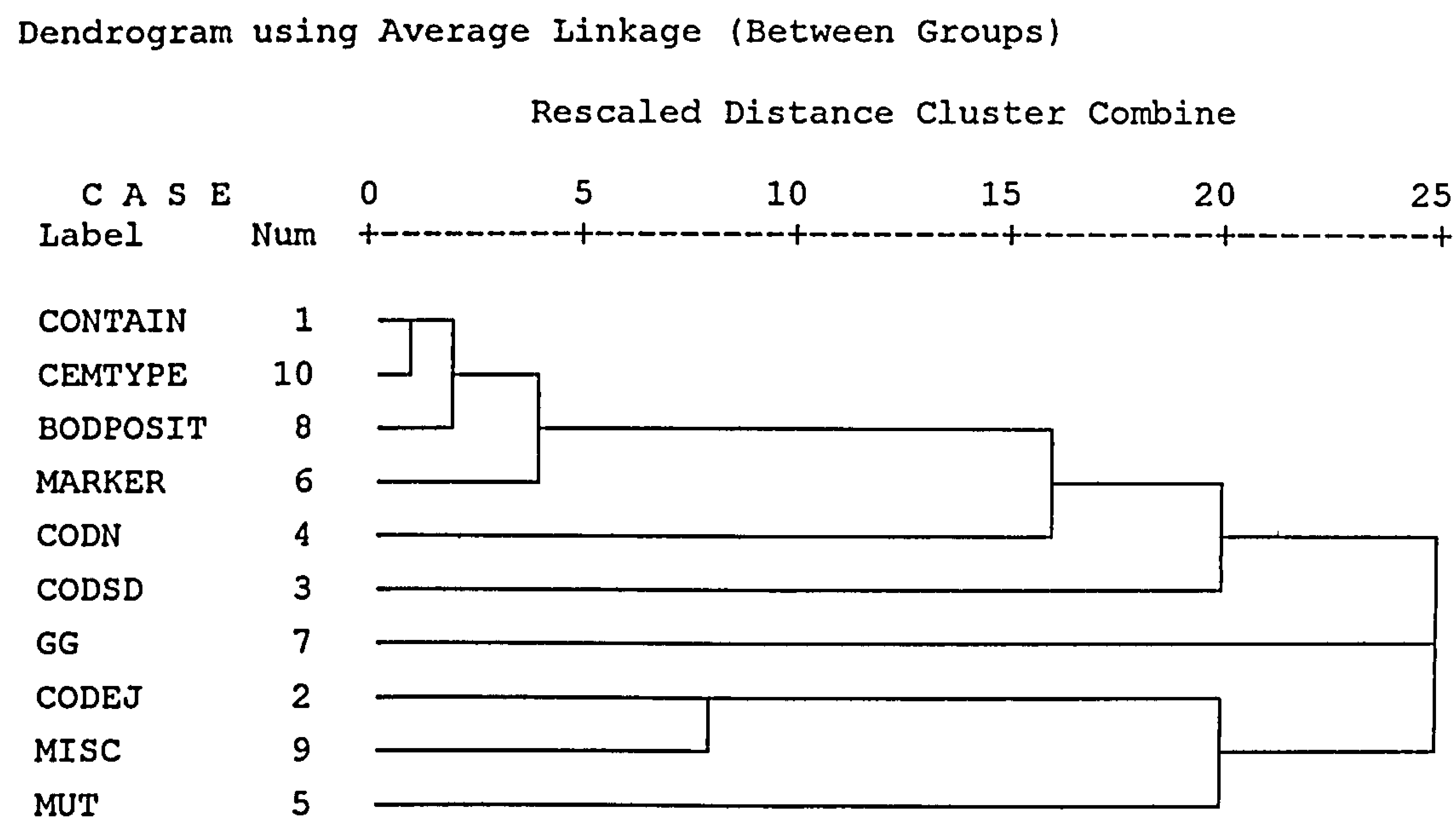



**Figure F.5** Spain Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

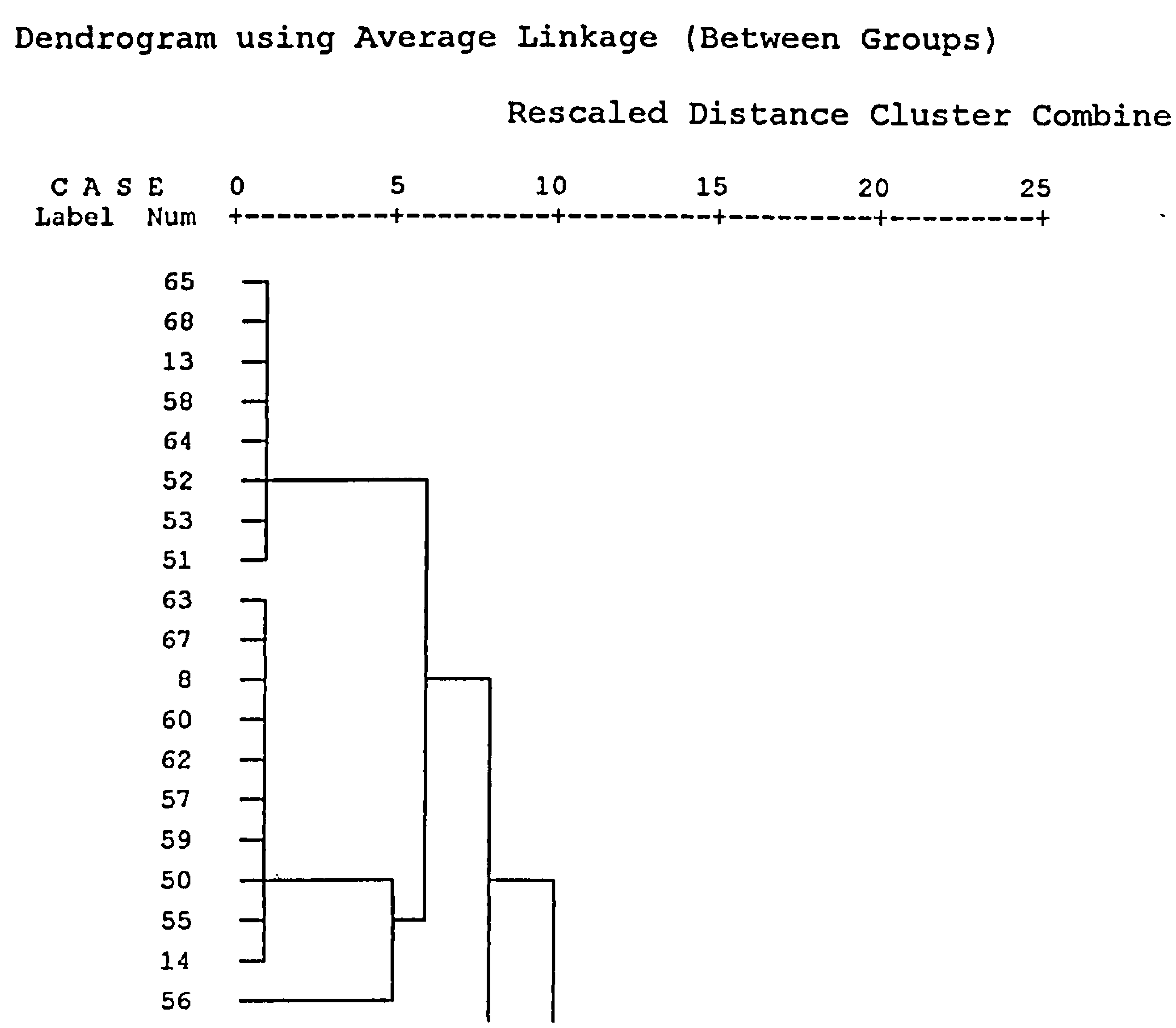



**Figure F.6** Spain Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

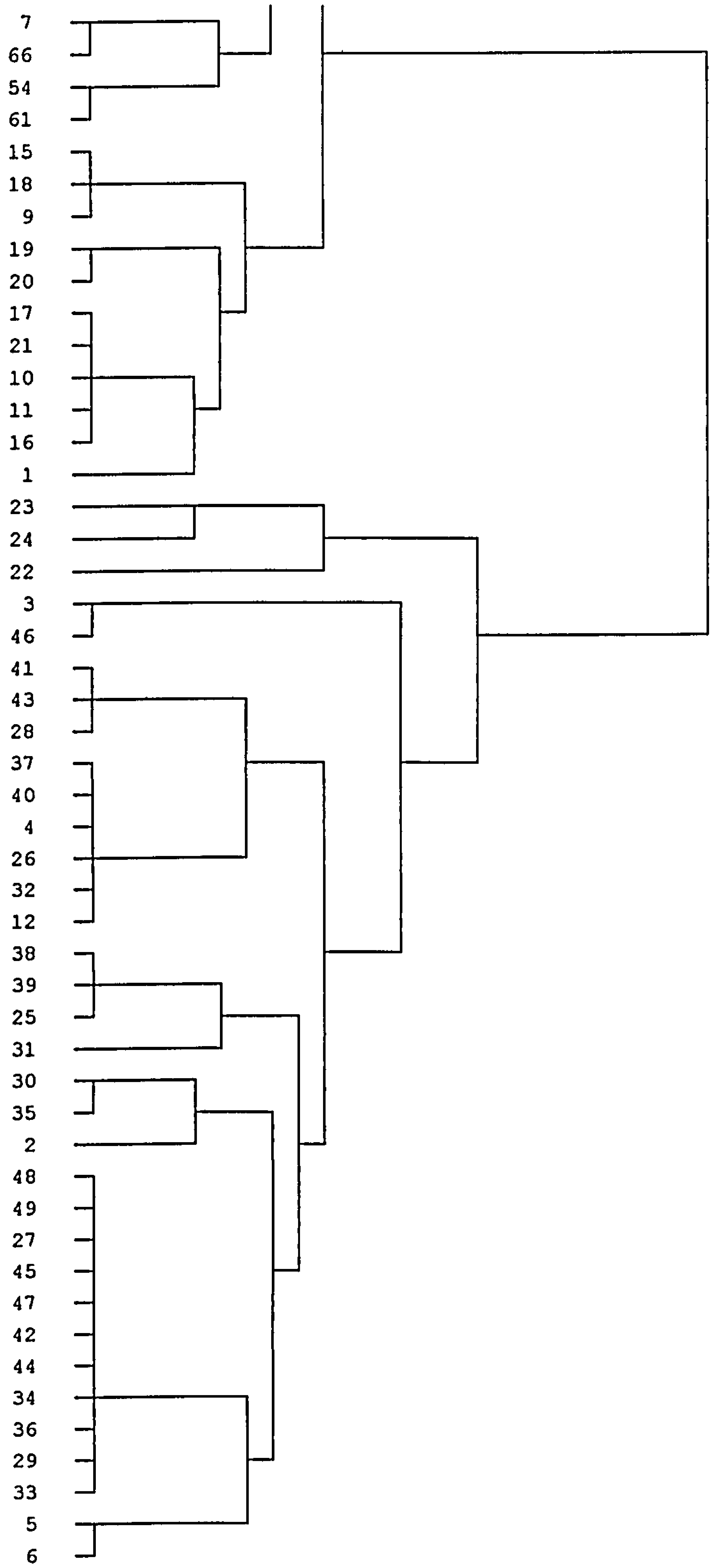



**Figure F.6** Spain Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Initial Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| CONTAIN | 0 | 0 | 1 |
| CODEJ | 1 | 1 | 0 |
| CODSD | 0 | 0 | 0 |
| CODN | 0 | 0 | 1 |
| MUT | 0 | 1 | 0 |
| MARKER | 1 | 0 | 0 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 1 | 0 | 1 |
| MISC | 0 | 1 | 0 |
| CEMTYPE | 1 | 0 | 1 |

**Table F.19** Spain Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Initial Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| CONTAIN | No | No | Yes |
| CODEJ | Yes | Yes | No |
| CODSD | No | No | No |
| CODN | No | No | Yes |
| MUT | No | Yes | No |
| MARKER | Yes | No | No |
| GG | No | No | No |
| BODPOSIT | Yes | No | Yes |
| MISC | No | Yes | No |
| CEMTYPE | Perm | Temp | Perm |

**Table F.20** Spain Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 8.000 |
| | 2 | 26.000 |
| | 3 | 34.000 |
| Valid | | 68.000 |
| Missing | | .000 |

**Table F.21** Spain Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

## F.4 Korea:

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.873 | 48.943 | 48.943 | 5.873 | 48.943 | 48.943 |
| 2 | 1.342 | 11.184 | 60.127 | 1.342 | 11.184 | 60.127 |
| 3 | 1.035 | 8.625 | 68.751 | 1.035 | 8.625 | 68.751 |
| 4 | .988 | 8.229 | 76.981 | | | |
| 5 | .847 | 7.061 | 84.042 | | | |
| 6 | .522 | 4.346 | 88.388 | | | |
| 7 | .481 | 4.009 | 92.397 | | | |
| 8 | .382 | 3.185 | 95.582 | | | |
| 9 | .321 | 2.672 | 98.253 | | | |
| 10 | .188 | 1.563 | 99.816 | | | |
| 11 | 2.206E-02 | .184 | 100.000 | | | |
| 12 | 9.082E-17 | 7.568E-16 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.22** Korea Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .962 |
| CONTAIN | 1.000 | .750 |
| CODCR | 1.000 | .929 |
| CODSD | 1.000 | .773 |
| CODN | 1.000 | .554 |
| MARKER | 1.000 | .564 |
| CLOTHING | 1.000 | .583 |
| GG | 1.000 | .734 |
| BODPOSIT | 1.000 | .700 |
| MISC | 1.000 | .469 |
| CEMTYPE | 1.000 | .962 |
| OBINTNT | 1.000 | .270 |

Extraction Method: Principal Component Analysis.

**Table F.23** Korea Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODSD | CODN | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | .836 | -.973 | .221 | .415 | .688 | .439 | .217 | .809 | -.563 | 1.000 | -.315 |
| | CONTAIN | .836 | 1.000 | -.813 | .212 | .329 | .579 | .398 | .171 | .662 | -.462 | .836 | -.264 |
| | CODCR | -.973 | -.813 | 1.000 | -.285 | -.404 | -.670 | -.462 | -.211 | -.777 | .511 | -.973 | .204 |
| | CODSD | .221 | .212 | -.285 | 1.000 | -.239 | .083 | .229 | -.001 | .195 | -.094 | .221 | .067 |
| | CODN | .415 | .329 | -.404 | -.239 | 1.000 | .382 | .136 | .023 | .322 | -.262 | .415 | -.131 |
| | MARKER | .688 | .579 | -.670 | .083 | .382 | 1.000 | .353 | .141 | .528 | -.370 | .688 | -.217 |
| | CLOTHING | .439 | .398 | -.462 | .229 | .136 | .353 | 1.000 | .222 | .345 | -.007 | .439 | -.189 |
| | GG | .217 | .171 | -.211 | -.001 | .023 | .141 | .222 | 1.000 | .105 | -.137 | .217 | -.068 |
| | BODPOSIT | .809 | .662 | -.777 | .195 | .322 | .528 | .345 | .105 | 1.000 | -.406 | .809 | -.220 |
| | MISC | -.563 | -.462 | .511 | -.094 | -.262 | -.370 | -.007 | -.137 | -.406 | 1.000 | -.563 | .349 |
| | CEMTYPE | 1.000 | .836 | -.973 | .221 | .415 | .688 | .439 | .217 | .809 | -.563 | 1.000 | -.315 |
| | OBINTNT | -.315 | -.264 | .204 | .067 | -.131 | -.217 | -.189 | -.068 | -.220 | .349 | -.315 | 1.000 |

**Table F.24** Korea Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODSD | CODN | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
| STATUS | 1.000 | .873 | .000 | .196 | .382 | .727 | .677 | .127 | .883 | .015 | 1.000 | .000 |
| CONTAIN | .873 | 1.000 | .000 | .200 | .353 | .660 | .619 | .122 | .767 | .016 | .873 | .000 |
| CODCR | .000 | .000 | 1.000 | .000 | .000 | .000 | .125 | .000 | .063 | .414 | .000 | .107 |
| CODSD | .196 | .200 | .000 | 1.000 | .000 | .156 | .200 | .056 | .186 | .040 | .196 | .067 |
| CODN | .382 | .353 | .000 | .000 | 1.000 | .386 | .271 | .077 | .339 | .000 | .382 | .000 |
| MARKER | .727 | .660 | .000 | .156 | .386 | 1.000 | .541 | .119 | .633 | .019 | .727 | .000 |
| CLOTHING | .677 | .619 | .125 | .200 | .271 | .541 | 1.000 | .130 | .647 | .153 | .677 | .018 |
| GG | .127 | .122 | .000 | .056 | .077 | .119 | .130 | 1.000 | .102 | .000 | .127 | .000 |
| BODPOSIT | .883 | .767 | .063 | .186 | .339 | .633 | .647 | .102 | 1.000 | .059 | .883 | .016 |
| MISC | .015 | .016 | .414 | .040 | .000 | .019 | .153 | .000 | .059 | 1.000 | .015 | .200 |
| CEMTYPE | 1.000 | .873 | .000 | .196 | .382 | .727 | .677 | .127 | .883 | .015 | 1.000 | .000 |
| OBINTNT | .000 | .000 | .107 | .067 | .000 | .000 | .018 | .000 | .016 | .200 | .000 | 1.000 |

**Table F.25** Korea Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

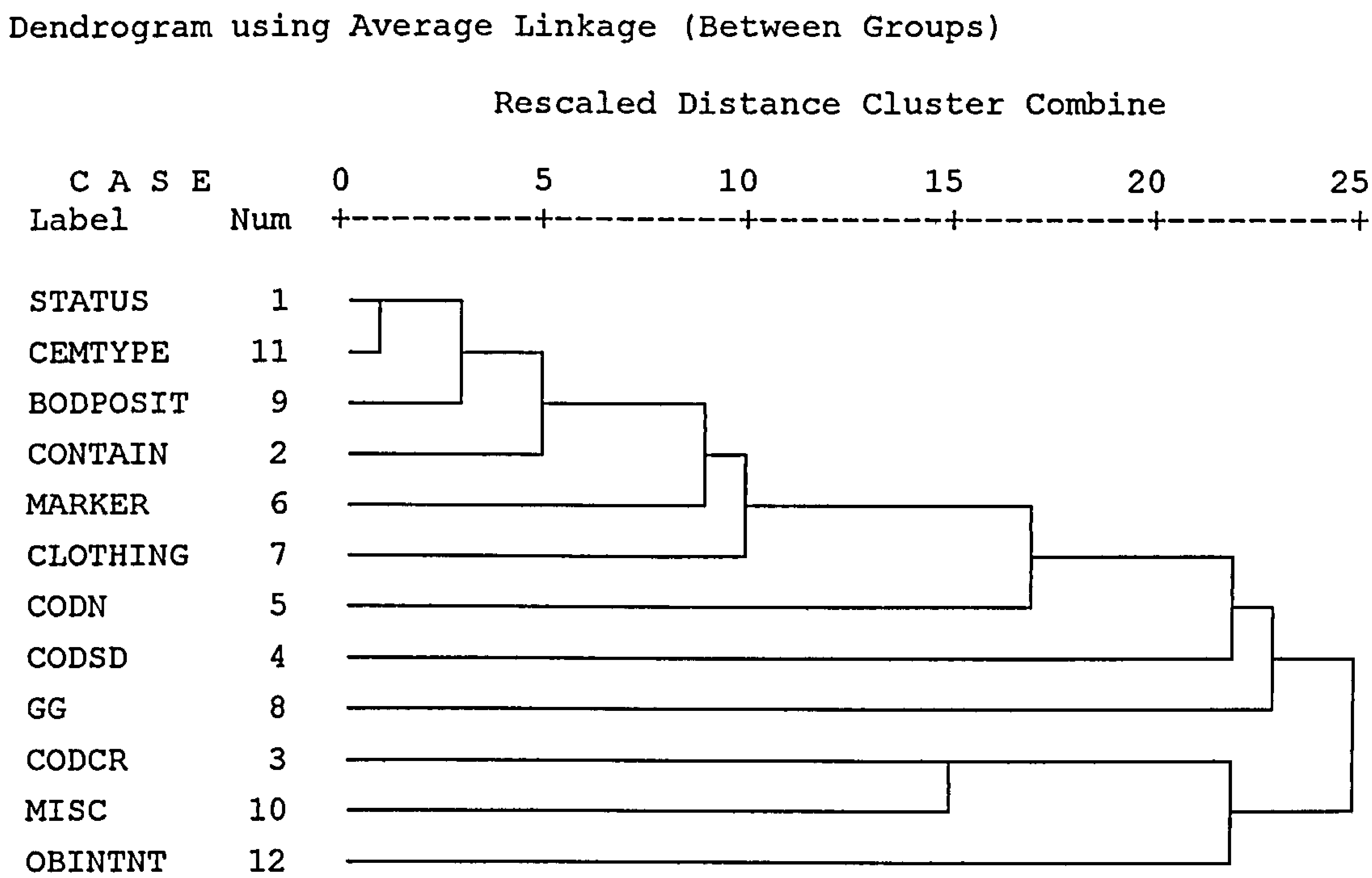



**Figure F.7** Korea Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

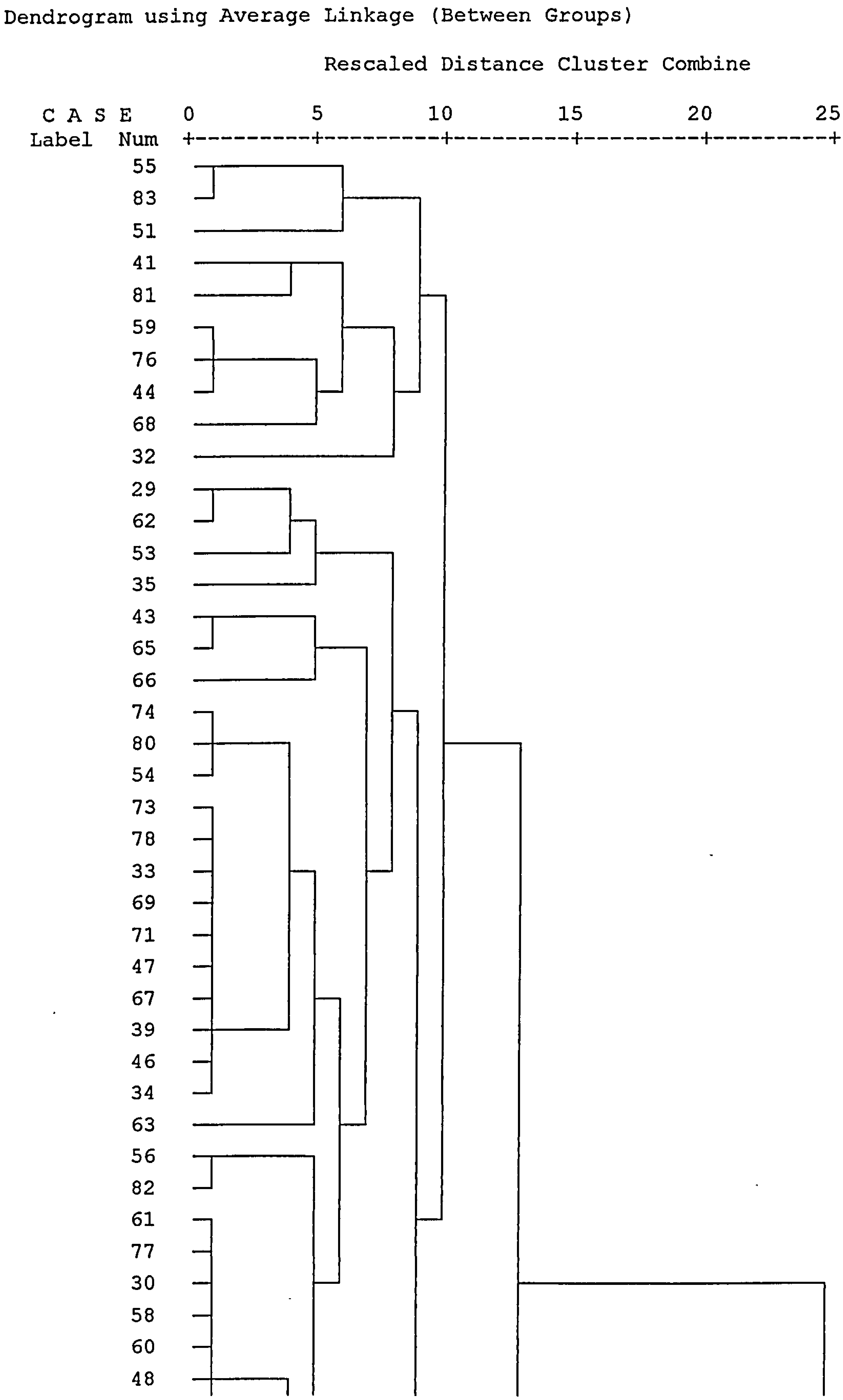



**Figure F.8** Korea Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

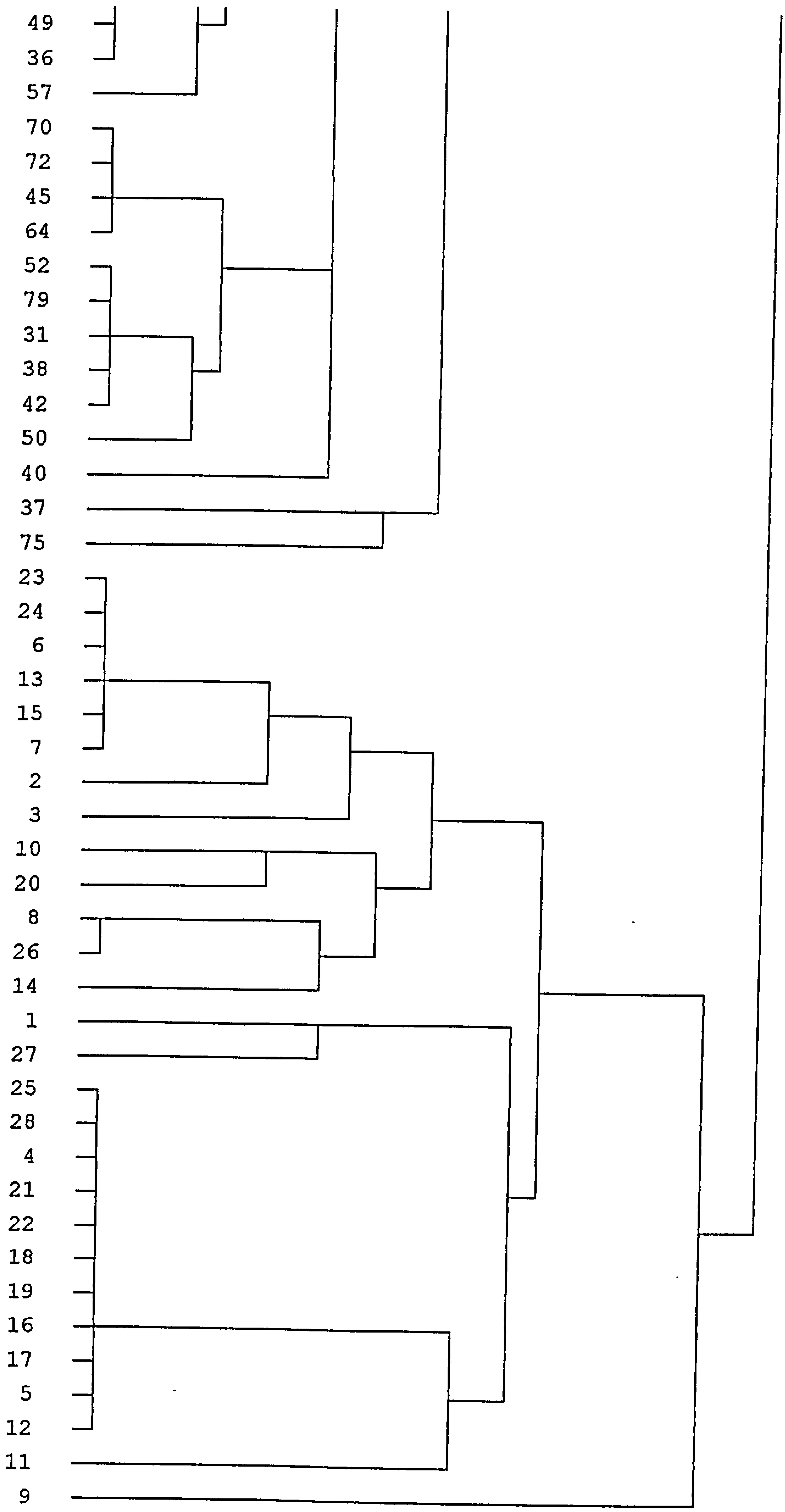



**Figure F.8** Korea Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | 1 | 0 | 1 |
| CONTAIN | 1 | 0 | 1 |
| CODCR | 0 | 1 | 0 |
| CODSD | 0 | 0 | 0 |
| CODN | 1 | 0 | 0 |
| MARKER | 0 | 0 | 1 |
| CLOTHING | 0 | 0 | 1 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 1 | 0 | 1 |
| MISC | 0 | 0 | 0 |
| CEMTYPE | 1 | 0 | 1 |
| OBINTNT | 0 | 0 | 0 |

**Table F.26** Korea Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | Civilian | Military | Civilian |
| CONTAIN | Yes | No | Yes |
| CODCR | No | Yes | No |
| CODSD | No | No | No |
| CODN | Yes | No | No |
| MARKER | No | No | Yes |
| CLOTHING | No | No | Yes |
| GG | No | No | No |
| BODPOSIT | Norm | No | Norm |
| MISC | No | No | No |
| CEMTYPE | Perm | Temp | Perm |
| OBINTNT | No | No | No |

**Table F.27** Korea Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 18.000 |
| | 2 | 28.000 |
| | 3 | 37.000 |
| Valid | | 83.000 |
| Missing | | .000 |

**Table F.28** Korea Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

## F.5 Balkans:

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.788 | 41.345 | 41.345 | 5.788 | 41.345 | 41.345 |
| 2 | 1.693 | 12.095 | 53.440 | 1.693 | 12.095 | 53.440 |
| 3 | 1.649 | 11.777 | 65.217 | 1.649 | 11.777 | 65.217 |
| 4 | 1.104 | 7.883 | 73.100 | 1.104 | 7.883 | 73.100 |
| 5 | .963 | 6.876 | 79.977 | | | |
| 6 | .871 | 6.219 | 86.196 | | | |
| 7 | .599 | 4.275 | 90.471 | | | |
| 8 | .518 | 3.699 | 94.170 | | | |
| 9 | .378 | 2.698 | 96.868 | | | |
| 10 | .218 | 1.557 | 98.425 | | | |
| 11 | .140 | 1.003 | 99.428 | | | |
| 12 | 5.405E-02 | .386 | 99.814 | | | |
| 13 | 2.606E-02 | .186 | 100.000 | | | |
| 14 | 3.906E-16 | 2.790E-15 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.29** Balkans Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .787 |
| CONTAIN | 1.000 | .945 |
| CODCR | 1.000 | .561 |
| CODEJ | 1.000 | .851 |
| CODSD | 1.000 | .604 |
| CODN | 1.000 | .579 |
| MUT | 1.000 | .901 |
| MARKER | 1.000 | .487 |
| CLOTHING | 1.000 | .521 |
| GG | 1.000 | .449 |
| BODPOSIT | 1.000 | .851 |
| MISC | 1.000 | .902 |
| CEMTYPE | 1.000 | .847 |
| OBINTNT | 1.000 | .949 |

Extraction Method: Principal Component Analysis.

**Table F.30** Balkans Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | .602 | -.423 | -.416 | .174 | .265 | -.804 | .339 | -.250 | .133 | .615 | -.535 | -.017 | .034 |
| | CONTAIN | .602 | 1.000 | -.443 | -.807 | .240 | .440 | -.626 | .524 | -.415 | .221 | .849 | -.915 | .719 | -.152 |
| | CODCR | -.423 | -.443 | 1.000 | -.131 | -.128 | -.195 | .505 | -.249 | .184 | -.098 | -.376 | .484 | -.158 | -.025 |
| | CODEJ | -.416 | -.807 | -.131 | 1.000 | -.233 | -.355 | .391 | -.454 | .335 | -.179 | -.728 | .732 | -.716 | .188 |
| | CODSD | .174 | .240 | -.128 | -.233 | 1.000 | -.345 | -.181 | .036 | -.324 | -.107 | .135 | -.264 | .208 | -.044 |
| | CODN | .265 | .440 | -.195 | -.355 | -.345 | 1.000 | -.275 | .321 | -.072 | .284 | .430 | -.402 | .316 | -.067 |
| | MUT | -.804 | -.626 | .505 | .391 | -.181 | -.275 | 1.000 | -.352 | .260 | -.139 | -.524 | .625 | -.042 | .242 |
| | MARKER | .339 | .524 | -.249 | -.454 | .036 | .321 | -.352 | 1.000 | -.052 | .342 | .512 | -.514 | .404 | -.085 |
| | CLOTHING | -.250 | -.415 | .184 | .335 | -.324 | -.072 | .260 | -.052 | 1.000 | .194 | -.365 | .380 | -.299 | .063 |
| | GG | .133 | .221 | -.098 | -.179 | -.107 | .284 | -.139 | .342 | .194 | 1.000 | .217 | -.203 | .159 | -.034 |
| | BODPOSIT | .615 | .849 | -.376 | -.728 | .135 | .430 | -.524 | .512 | -.365 | .217 | 1.000 | -.844 | .578 | .055 |
| | MISC | -.535 | -.915 | .484 | .732 | -.264 | -.402 | .625 | -.514 | .380 | -.203 | -.844 | 1.000 | -.624 | -.051 |
| | CEMTYPE | -.017 | .719 | -.158 | -.716 | .208 | .316 | -.042 | .404 | -.299 | .159 | .578 | -.624 | 1.000 | -.211 |
| | OBINTNT | .034 | -.152 | -.025 | .188 | -.044 | -.067 | .242 | -.085 | .063 | -.034 | .055 | -.051 | -.211 | 1.000 |

**Table F.31** Balkans Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE | OBINTNT |
| STATUS | 1.000 | .829 | .027 | .123 | .210 | .390 | .026 | .524 | .563 | .133 | .838 | .137 | .752 | .010 |
| CONTAIN | .829 | 1.000 | .000 | .000 | .239 | .471 | .000 | .614 | .412 | .161 | .923 | .000 | .870 | .000 |
| CODCR | .027 | .000 | 1.000 | .000 | .000 | .000 | .353 | .000 | .099 | .000 | .011 | .286 | .049 | .000 |
| CODEJ | .123 | .000 | .000 | 1.000 | .000 | .000 | .310 | .000 | .284 | .000 | .018 | .645 | .060 | .043 |
| CODSD | .210 | .239 | .000 | .000 | 1.000 | .000 | .000 | .167 | .084 | .029 | .209 | .000 | .220 | .000 |
| CODN | .390 | .471 | .000 | .000 | .000 | 1.000 | .000 | .412 | .271 | .222 | .466 | .000 | .410 | .000 |
| MUT | .026 | .000 | .353 | .310 | .000 | .000 | 1.000 | .000 | .185 | .000 | .020 | .483 | .117 | .067 |
| MARKER | .524 | .614 | .000 | .000 | .167 | .412 | .000 | 1.000 | .360 | .232 | .607 | .000 | .550 | .000 |
| CLOTHING | .563 | .412 | .099 | .284 | .084 | .271 | .185 | .360 | 1.000 | .159 | .432 | .346 | .521 | .012 |
| GG | .133 | .161 | .000 | .000 | .029 | .222 | .000 | .232 | .159 | 1.000 | .159 | .000 | .140 | .000 |
| BODPOSIT | .838 | .923 | .011 | .018 | .209 | .466 | .020 | .607 | .432 | .159 | 1.000 | .018 | .825 | .011 |
| MISC | .137 | .000 | .286 | .645 | .000 | .000 | .483 | .000 | .346 | .000 | .018 | 1.000 | .103 | .000 |
| CEMTYPE | .752 | .870 | .049 | .060 | .220 | .410 | .117 | .550 | .521 | .140 | .825 | .103 | 1.000 | .000 |
| OBINTNT | .010 | .000 | .000 | .043 | .000 | .000 | .067 | .000 | .012 | .000 | .011 | .000 | .000 | 1.000 |

**Table F.32** Balkans Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

Dendrogram using Average Linkage (Between Groups)

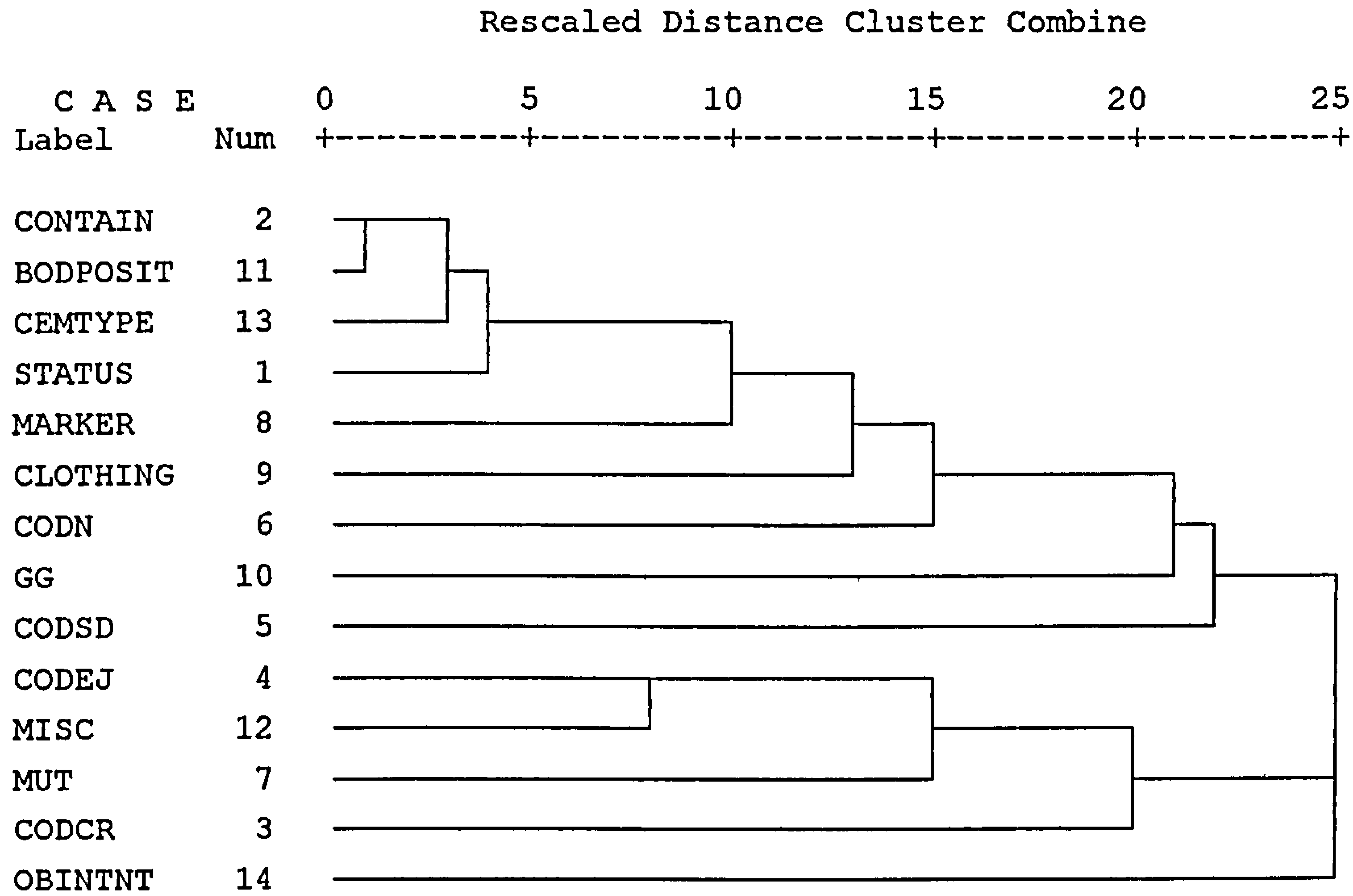



**Figure F.9** Balkans Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

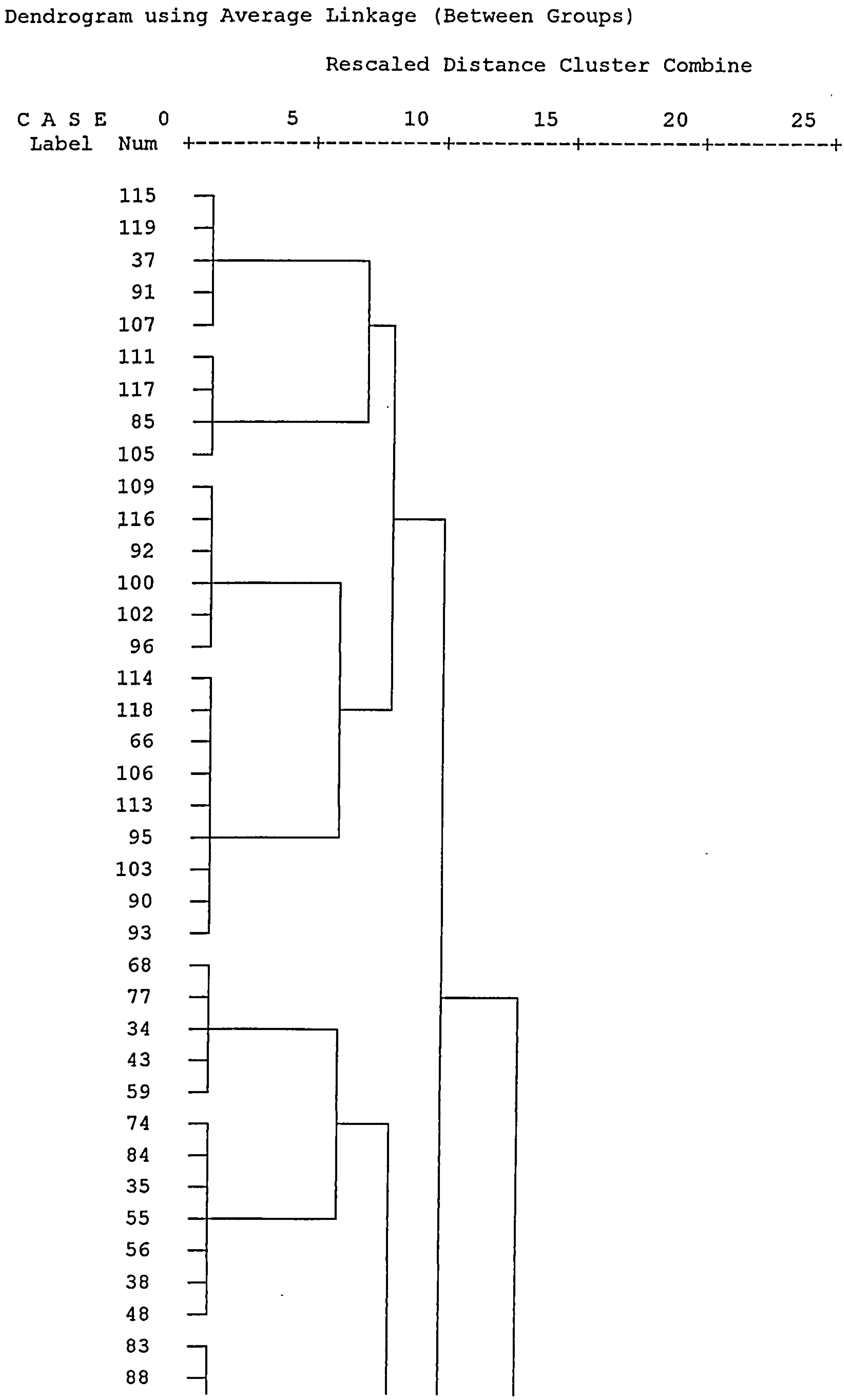



**Figure F.10** Balkans Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

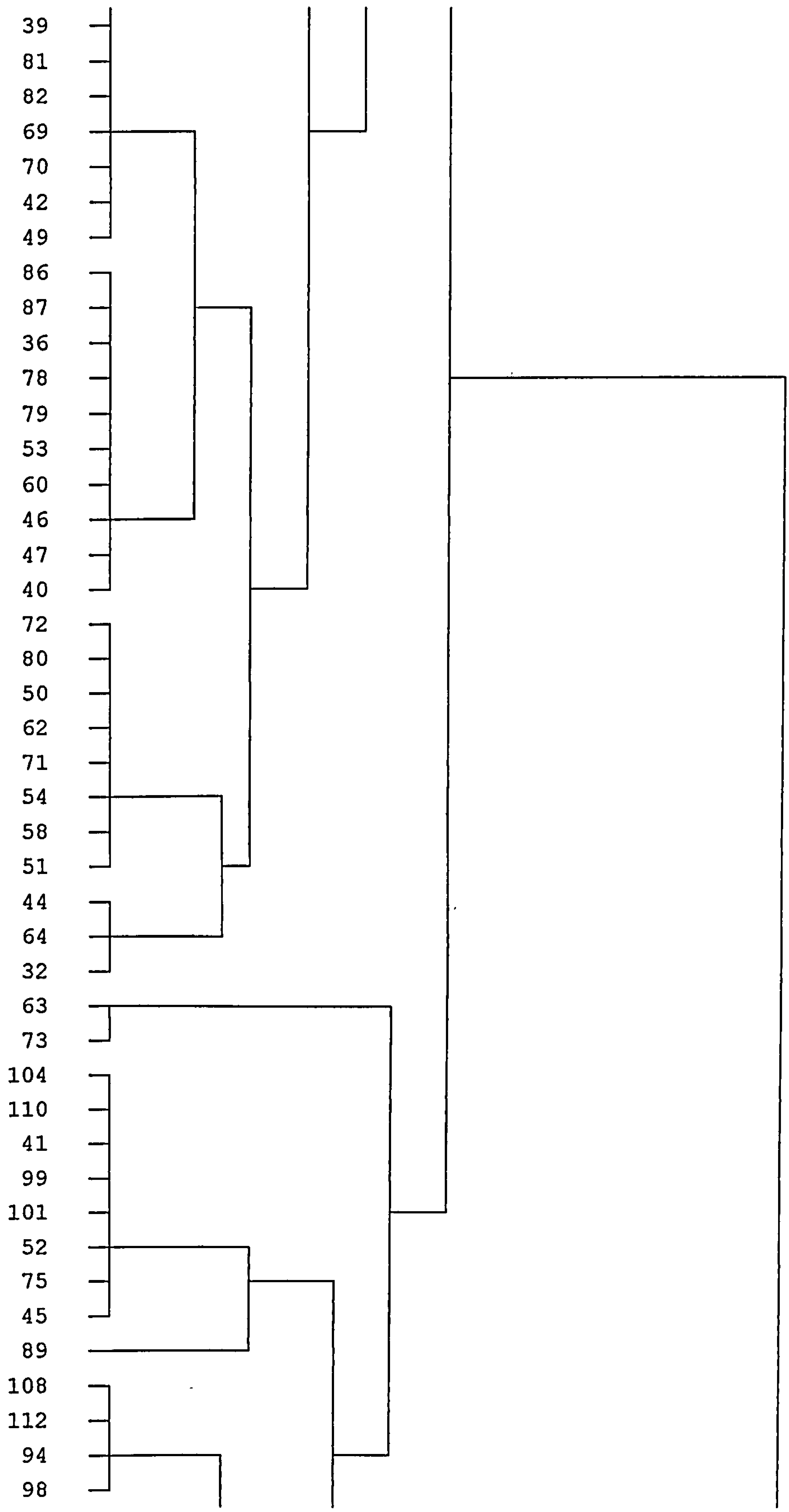



**Figure F.10** Balkans Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

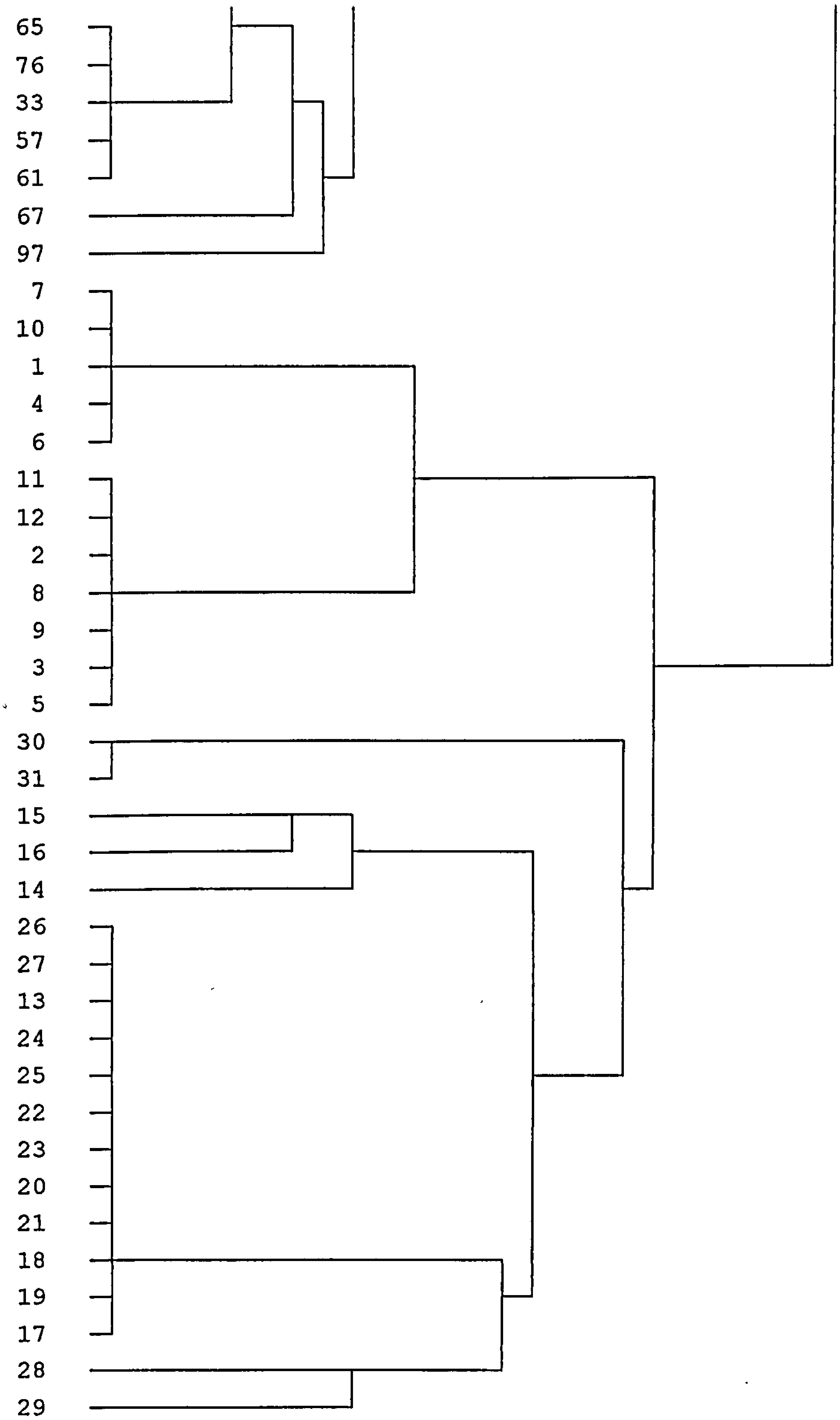



**Figure F.10** Balkans Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | 1 | 1 | 1 |
| CONTAIN | 0 | 1 | 1 |
| CODCR | 0 | 0 | 0 |
| CODEJ | 1 | 0 | 0 |
| CODSD | 0 | 1 | 0 |
| CODN | 0 | 0 | 1 |
| MUT | 0 | 0 | 0 |
| MARKER | 0 | 0 | 1 |
| CLOTHING | 1 | 0 | 1 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 0 | 1 | 1 |
| MISC | 1 | 0 | 0 |
| CEMTYPE | 0 | 1 | 1 |
| OBINTNT | 0 | 0 | 0 |

**Table F.33** Balkans Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | Civilian | Civilian | Civilian |
| CONTAIN | No | Yes | Yes |
| CODCR | No | No | No |
| CODEJ | Yes | No | No |
| CODSD | No | Yes | No |
| CODN | No | No | Yes |
| MUT | No | No | No |
| MARKER | No | No | Yes |
| CLOTHING | Yes | No | Yes |
| GG | No | No | No |
| BODPOSIT | No | Norm | Norm |
| MISC | Yes | No | No |
| CEMTYPE | Temp | Perm | Perm |
| OBINTNT | No | No | No |

**Table F.34** Balkans Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 31.000 |
| | 2 | 31.000 |
| | 3 | 57.000 |
| Valid | | 119.000 |
| Missing | | .000 |

**Table F.35** Balkans Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

## F.6 19th Century North America

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.972 | 41.432 | 41.432 | 4.972 | 41.432 | 41.432 |
| 2 | 1.621 | 13.505 | 54.937 | 1.621 | 13.505 | 54.937 |
| 3 | 1.117 | 9.312 | 64.249 | 1.117 | 9.312 | 64.249 |
| 4 | .958 | 7.986 | 72.235 | | | |
| 5 | .775 | 6.459 | 78.694 | | | |
| 6 | .676 | 5.632 | 84.326 | | | |
| 7 | .517 | 4.309 | 88.635 | | | |
| 8 | .461 | 3.839 | 92.474 | | | |
| 9 | .388 | 3.236 | 95.709 | | | |
| 10 | .286 | 2.386 | 98.095 | | | |
| 11 | .144 | 1.201 | 99.297 | | | |
| 12 | 8.441E-02 | .703 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.36** 19th Century Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .889 |
| CONTAIN | 1.000 | .807 |
| CODCR | 1.000 | .871 |
| CODSD | 1.000 | .521 |
| CODN | 1.000 | .716 |
| MUT | 1.000 | .318 |
| MARKER | 1.000 | .702 |
| CLOTHING | 1.000 | .651 |
| GG | 1.000 | .265 |
| BODPOSIT | 1.000 | .670 |
| MISC | 1.000 | .538 |
| CEMTYPE | 1.000 | .761 |

Extraction Method: Principal Component Analysis.

**Table F.37** 19th Century Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | .820 | -.895 | .513 | .213 | -.430 | -.325 | -.662 | .173 | .330 | -.560 | .400 |
| | CONTAIN | .820 | 1.000 | -.872 | .420 | .175 | -.414 | -.410 | -.496 | .142 | .431 | -.600 | .488 |
| | CODCR | -.895 | -.872 | 1.000 | -.459 | -.191 | .480 | .371 | .566 | -.155 | -.364 | .585 | -.447 |
| | CODSD | .513 | .420 | -.459 | 1.000 | -.082 | -.221 | -.118 | -.307 | .135 | .150 | -.312 | .205 |
| | CODN | .213 | .175 | -.191 | -.082 | 1.000 | -.092 | -.082 | -.102 | -.028 | .139 | .001 | .085 |
| | MUT | -.430 | -.414 | .480 | -.221 | -.092 | 1.000 | .300 | .289 | -.074 | -.257 | .356 | -.205 |
| | MARKER | -.325 | -.410 | .371 | -.118 | -.082 | .300 | 1.000 | .117 | -.067 | -.527 | .444 | -.651 |
| | CLOTHING | -.662 | -.496 | .566 | -.307 | -.102 | .289 | .117 | 1.000 | -.032 | -.049 | .376 | -.078 |
| | GG | .173 | .142 | -.155 | .135 | -.028 | -.074 | -.067 | -.032 | 1.000 | .113 | -.105 | .069 |
| | BODPOSIT | .330 | .431 | -.364 | .150 | .139 | -.257 | -.527 | -.049 | .113 | 1.000 | -.298 | .612 |
| | MISC | -.560 | -.600 | .585 | -.312 | .001 | .356 | .444 | .376 | -.105 | -.298 | 1.000 | -.413 |
| | CEMTYPE | .400 | .488 | -.447 | .205 | .085 | -.205 | -.651 | -.078 | .069 | .612 | -.413 | 1.000 |

**Table F.38** 19th Century Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODSD | CODN | MUT | MARKER | CLOTHING | GG | BODPOSIT | MISC | CEMTYPE |
| STATUS | 1.000 | .813 | .000 | .385 | .077 | .000 | .019 | .106 | .051 | .492 | .015 | .520 |
| CONTAIN | .813 | 1.000 | .056 | .313 | .063 | .031 | .016 | .212 | .042 | .606 | .040 | .640 |
| CODCR | .000 | .056 | 1.000 | .000 | .000 | .383 | .292 | .672 | .000 | .265 | .571 | .341 |
| CODSD | .385 | .313 | .000 | 1.000 | .000 | .000 | .034 | .061 | .063 | .197 | .000 | .200 |
| CODN | .077 | .063 | .000 | .000 | 1.000 | .000 | .000 | .018 | .000 | .052 | .031 | .040 |
| MUT | .000 | .031 | .383 | .000 | .000 | 1.000 | .269 | .281 | .000 | .101 | .333 | .148 |
| MARKER | .019 | .016 | .292 | .034 | .000 | .269 | 1.000 | .186 | .000 | .014 | .364 | .047 |
| CLOTHING | .106 | .212 | .672 | .061 | .018 | .281 | .186 | 1.000 | .018 | .430 | .441 | .512 |
| GG | .051 | .042 | .000 | .063 | .000 | .000 | .000 | .018 | 1.000 | .034 | .000 | .027 |
| BODPOSIT | .492 | .606 | .265 | .197 | .052 | .101 | .014 | .430 | .034 | 1.000 | .173 | .773 |
| MISC | .015 | .040 | .571 | .000 | .031 | .333 | .364 | .441 | .000 | .173 | 1.000 | .207 |
| CEMTYPE | .520 | .640 | .341 | .200 | .040 | .148 | .047 | .512 | .027 | .773 | .207 | 1.000 |

**Table F.39** 19th Century Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

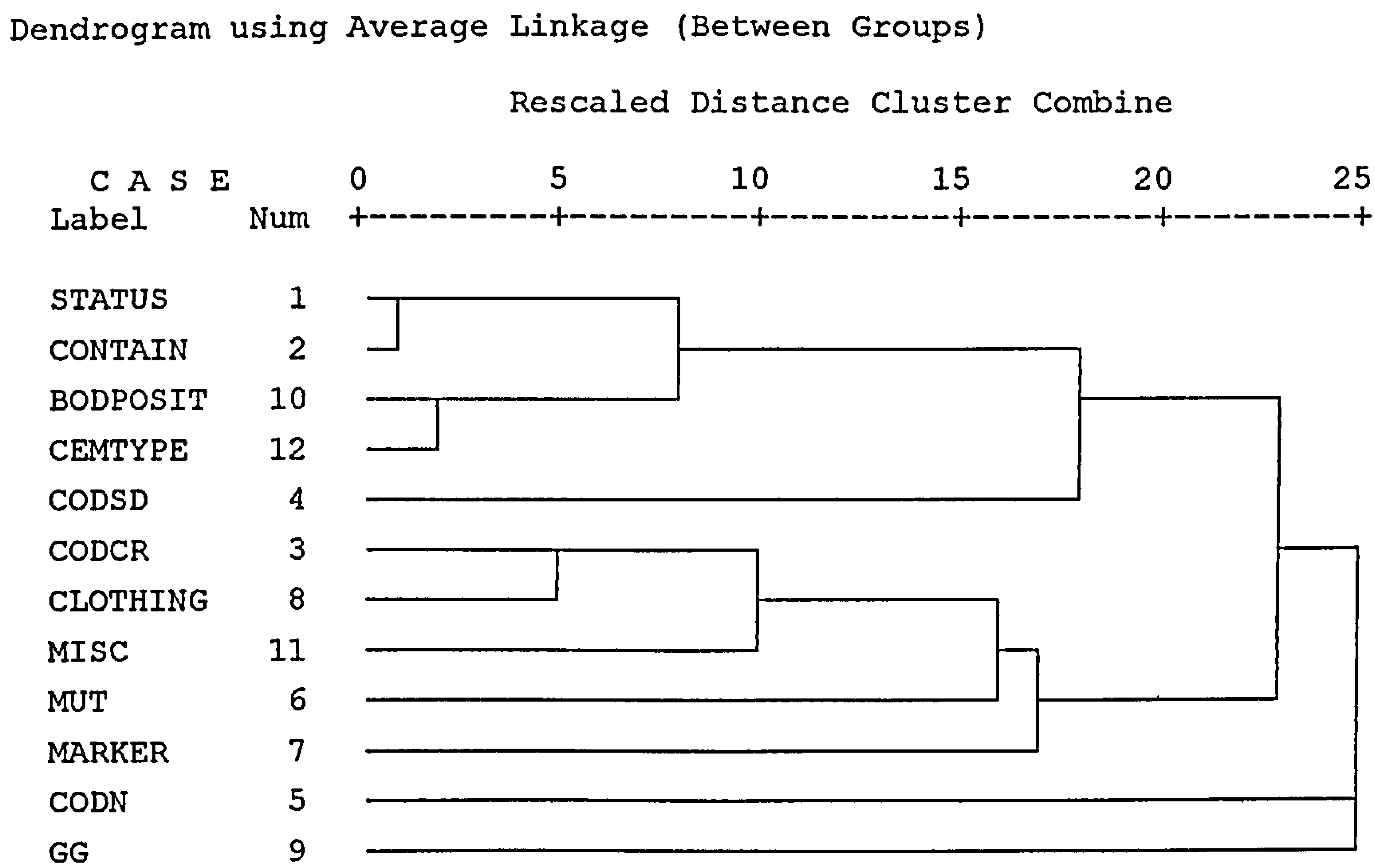



**Figure F.11** 19th Century Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

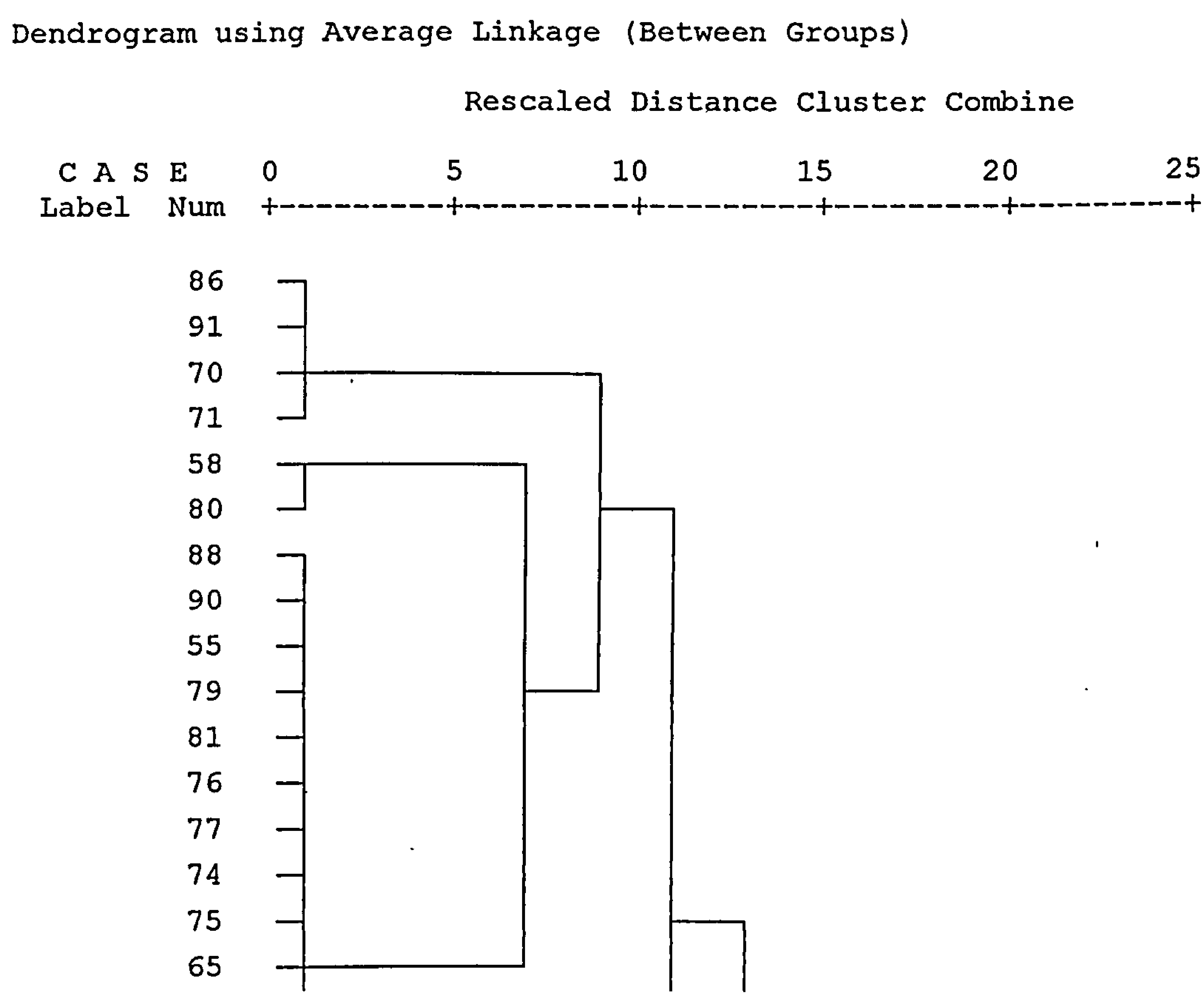



**Figure F.12** 19th Century Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

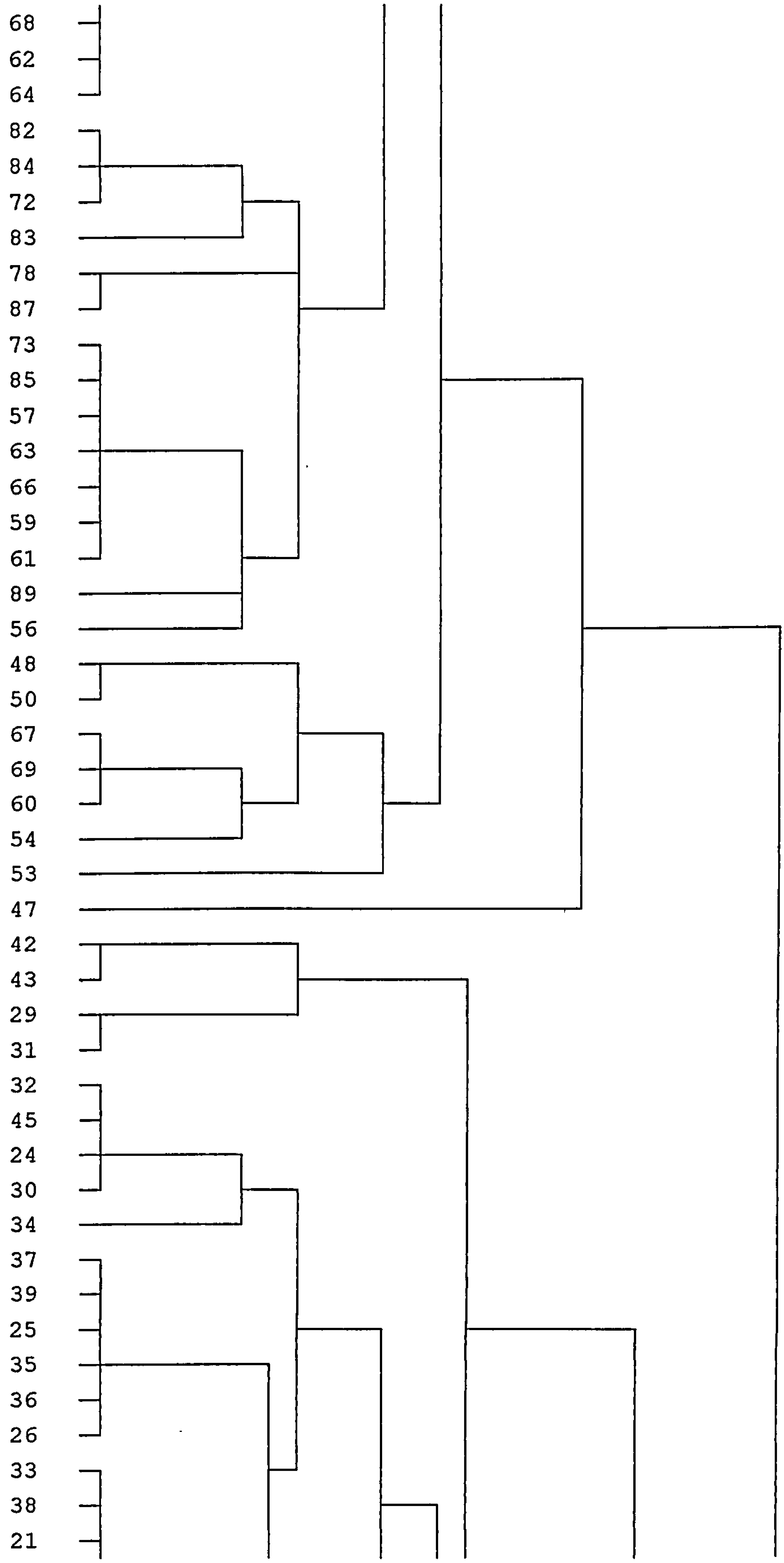



**Figure F.12** 19th Century Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

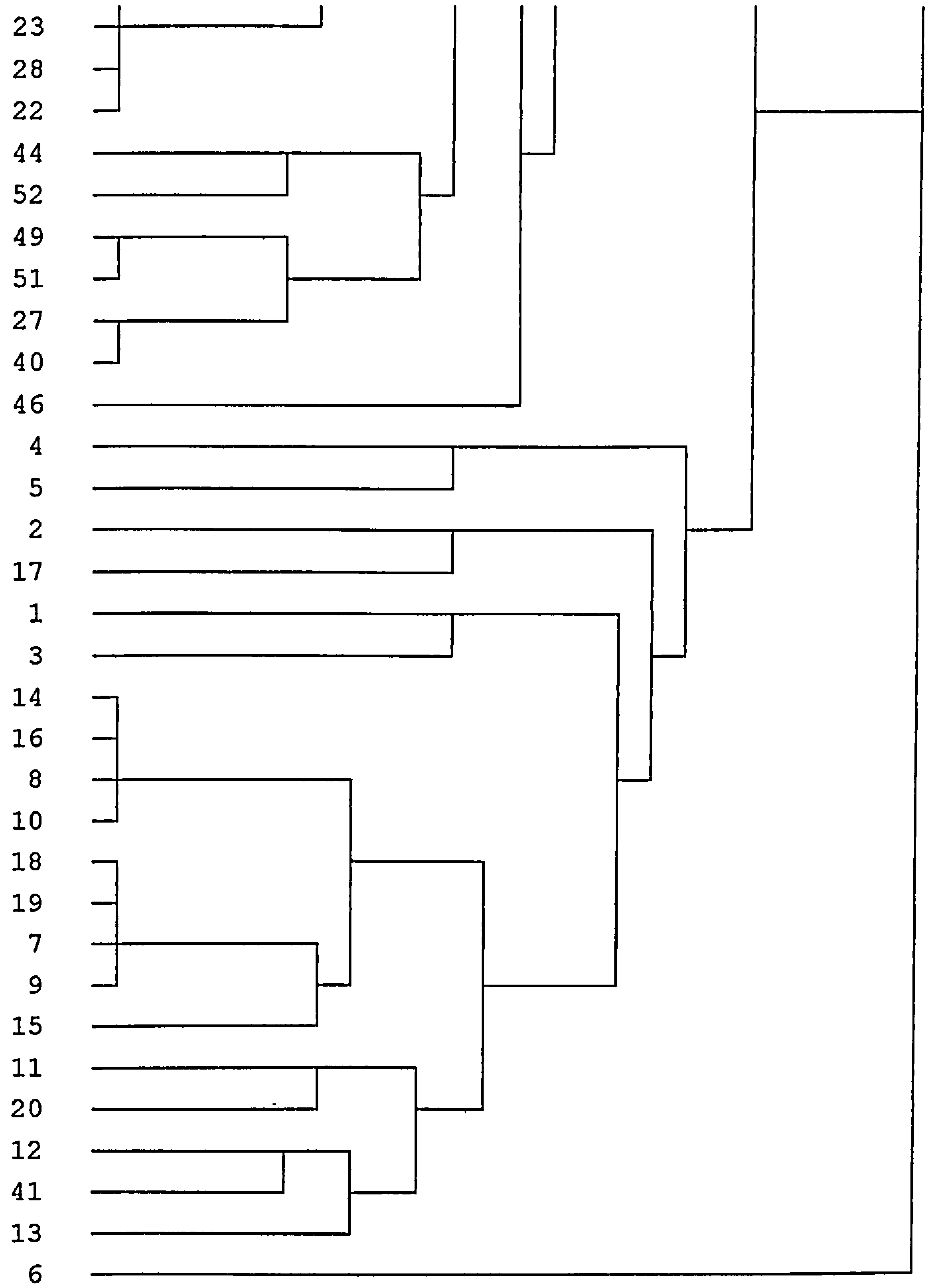



**Figure F.12** 19th Century Data - Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | 1 | 0 | 0 |
| CONTAIN | 1 | 0 | 0 |
| CODCR | 0 | 1 | 1 |
| CODSD | 0 | 0 | 0 |
| CODN | 0 | 0 | 0 |
| MUT | 0 | 0 | 0 |
| MARKER | 0 | 0 | 1 |
| CLOTHING | 0 | 1 | 1 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 1 | 1 | 0 |
| MISC | 0 | 0 | 1 |
| CEMTYPE | 1 | 1 | 0 |

**Table F.40** 19th Century Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | Civilian | Military | Military |
| CONTAIN | Yes | No | No |
| CODCR | No | Yes | Yes |
| CODSD | No | No | No |
| CODN | No | No | No |
| MUT | No | No | No |
| MARKER | No | No | Yes |
| CLOTHING | No | Yes | Yes |
| GG | No | No | No |
| BODPOSIT | Norm | Norm | No |
| MISC | No | No | Yes |
| CEMTYPE | Perm | Perm | Temp |

**Table F.41** 19th Century Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 42.000 |
| | 2 | 30.000 |
| | 3 | 19.000 |
| Valid | | 91.000 |
| Missing | | .000 |

**Table F.42** 19th Century Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

## F.7 Medieval

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 3.757 | 37.569 | 37.569 | 3.757 | 37.569 | 37.569 |
| 2 | 1.216 | 12.161 | 49.730 | 1.216 | 12.161 | 49.730 |
| 3 | 1.030 | 10.298 | 60.028 | 1.030 | 10.298 | 60.028 |
| 4 | 1.014 | 10.139 | 70.167 | 1.014 | 10.139 | 70.167 |
| 5 | .997 | 9.974 | 80.141 | | | |
| 6 | .918 | 9.179 | 89.320 | | | |
| 7 | .666 | 6.664 | 95.983 | | | |
| 8 | .262 | 2.619 | 98.602 | | | |
| 9 | .104 | 1.037 | 99.639 | | | |
| 10 | 3.610E-02 | .361 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

**Table F.43** Medieval Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Communalities**

| | Initial | Extraction |
|---|---|---|
| STATUS | 1.000 | .903 |
| CONTAIN | 1.000 | .618 |
| CODCR | 1.000 | .736 |
| CODN | 1.000 | .618 |
| MUT | 1.000 | .685 |
| MARKER | 1.000 | .730 |
| GG | 1.000 | .762 |
| BODPOSIT | 1.000 | .900 |
| MISC | 1.000 | .139 |
| CEMTYPE | 1.000 | .926 |

Extraction Method: Principal Component Analysis.

**Table F.44** Medieval Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Correlation Matrix**

| | | STATUS | CONTAIN | CODCR | CODN | MUT | MARKER | GG | BODPOSIT | MISC | CEMTYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | STATUS | 1.000 | .133 | -.682 | .133 | -.560 | .133 | -.148 | .833 | -.104 | .921 |
| | CONTAIN | .133 | 1.000 | -.098 | -.014 | -.082 | -.014 | -.020 | .133 | -.014 | .123 |
| | CODCR | -.682 | -.098 | 1.000 | -.098 | .719 | -.098 | .201 | -.513 | .141 | -.579 |
| | CODN | .133 | -.014 | -.098 | 1.000 | -.082 | -.014 | -.020 | .133 | -.014 | .123 |
| | MUT | -.560 | -.082 | .719 | -.082 | 1.000 | -.082 | .240 | -.383 | .168 | -.438 |
| | MARKER | .133 | -.014 | -.098 | -.014 | -.082 | 1.000 | -.020 | -.104 | -.014 | .123 |
| | GG | -.148 | -.020 | .201 | -.020 | .240 | -.020 | 1.000 | .021 | -.020 | .007 |
| | BODPOSIT | .833 | .133 | -.513 | .133 | -.383 | -.104 | .021 | 1.000 | -.104 | .921 |
| | MISC | -.104 | -.014 | .141 | -.014 | .168 | -.014 | -.020 | -.104 | 1.000 | -.113 |
| | CEMTYPE | .921 | .123 | -.579 | .123 | -.438 | .123 | .007 | .921 | -.113 | 1.000 |

**Table F.45** Medieval Data - Factor Analysis (coefficients; Principal Components (Correlation matrix) with Eigenvalues set to 1)

**Proximity Matrix**

| | Matrix File Input | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Case | STATUS | CONTAIN | CODCR | CODN | MUT | GG | BODPOSIT | MISC | CEMTYPE | MARKER |
| STATUS | 1.000 | .000 | .016 | .031 | .018 | .000 | .784 | .000 | .914 | .031 |
| CONTAIN | .000 | 1.000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| CODCR | .016 | .000 | 1.000 | .000 | .688 | .067 | .103 | .033 | .066 | .000 |
| CODN | .031 | .000 | .000 | 1.000 | .000 | .000 | .029 | .000 | .029 | .000 |
| MUT | .018 | .000 | .688 | .000 | 1.000 | .083 | .115 | .042 | .073 | .000 |
| GG | .000 | .000 | .067 | .000 | .083 | 1.000 | .029 | .000 | .028 | .000 |
| BODPOSIT | .784 | .000 | .103 | .029 | .115 | .029 | 1.000 | .000 | .865 | .000 |
| MISC | .000 | .000 | .033 | .000 | .042 | .000 | .000 | 1.000 | .000 | .000 |
| CEMTYPE | .914 | .000 | .066 | .029 | .073 | .028 | .865 | .000 | 1.000 | .029 |
| MARKER | .031 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .029 | 1.000 |

**Table F.46** Medieval Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

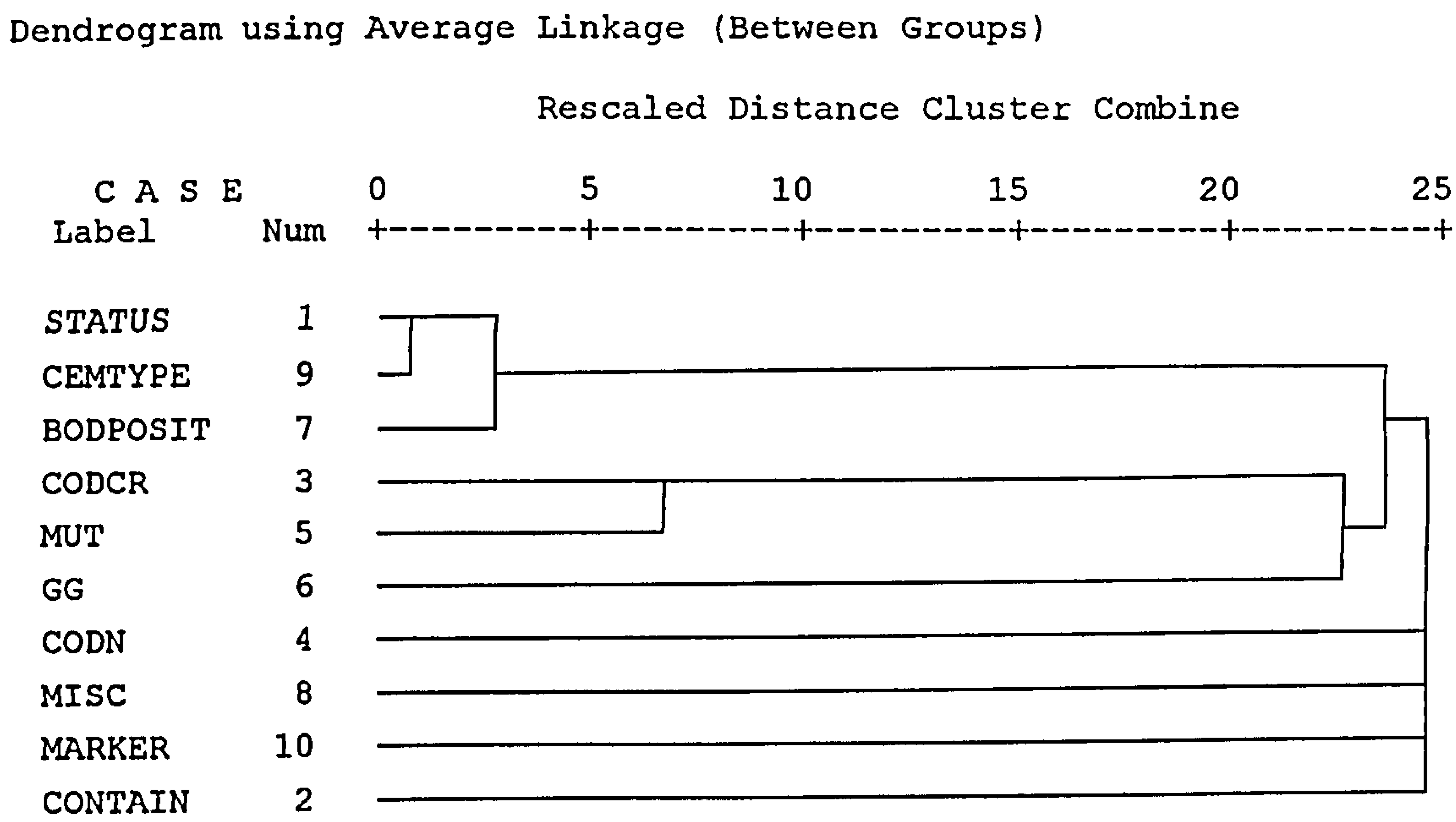



**Figure F.13** Medieval Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

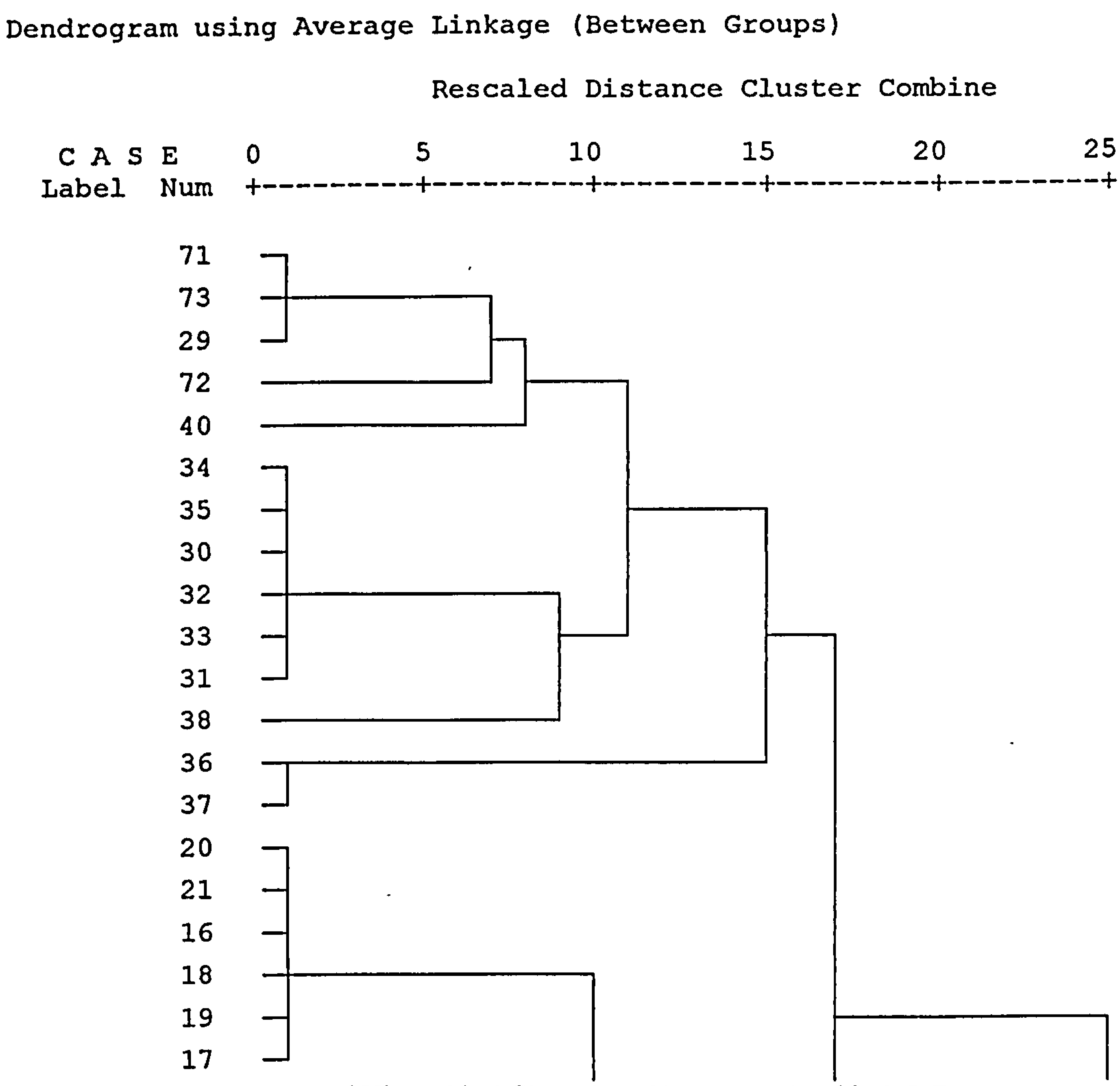



**Figure F.14** Medieval Data - 1 Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure

Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine

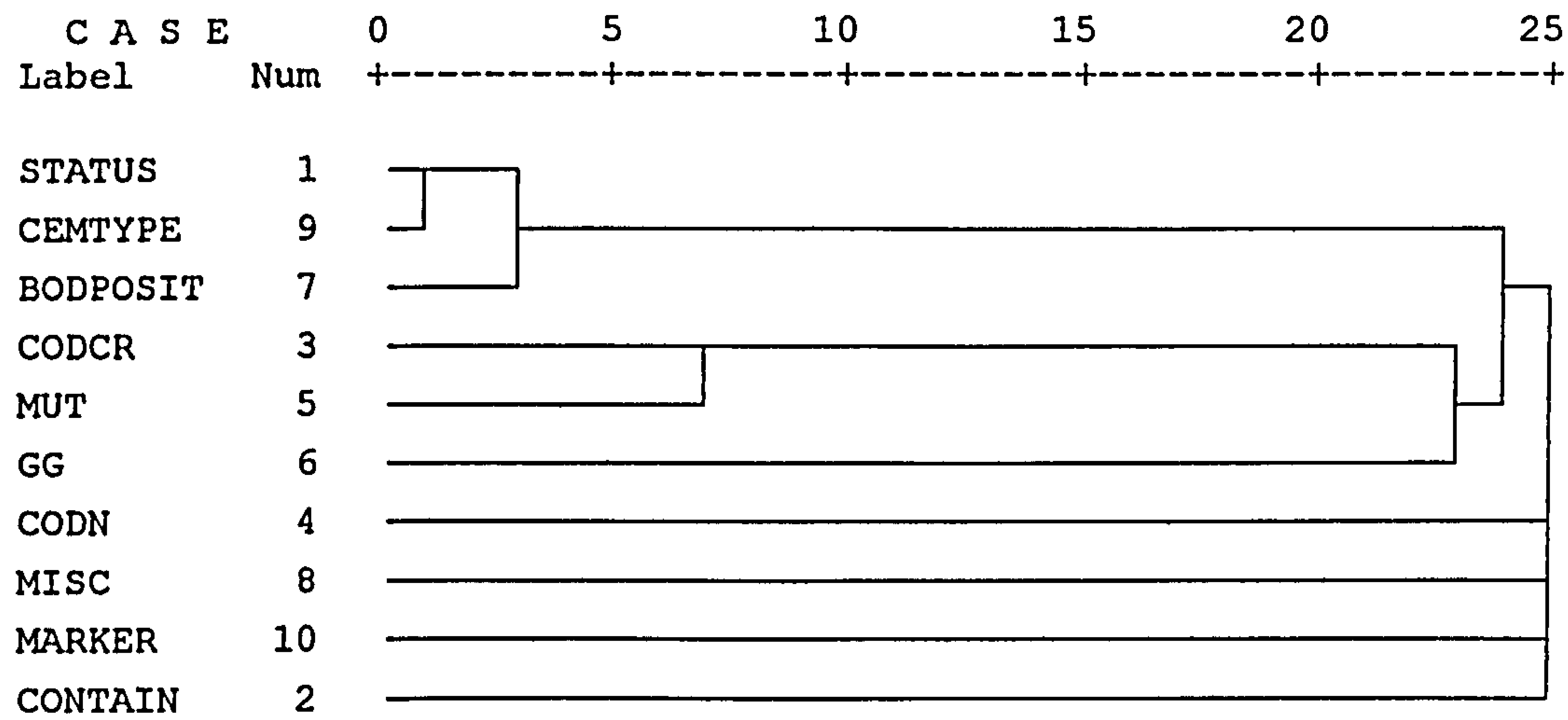



**Figure F.13** Medieval Data - Hierarchical Clustering: Between-group Average; Jaccard Measure of Variables

Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine

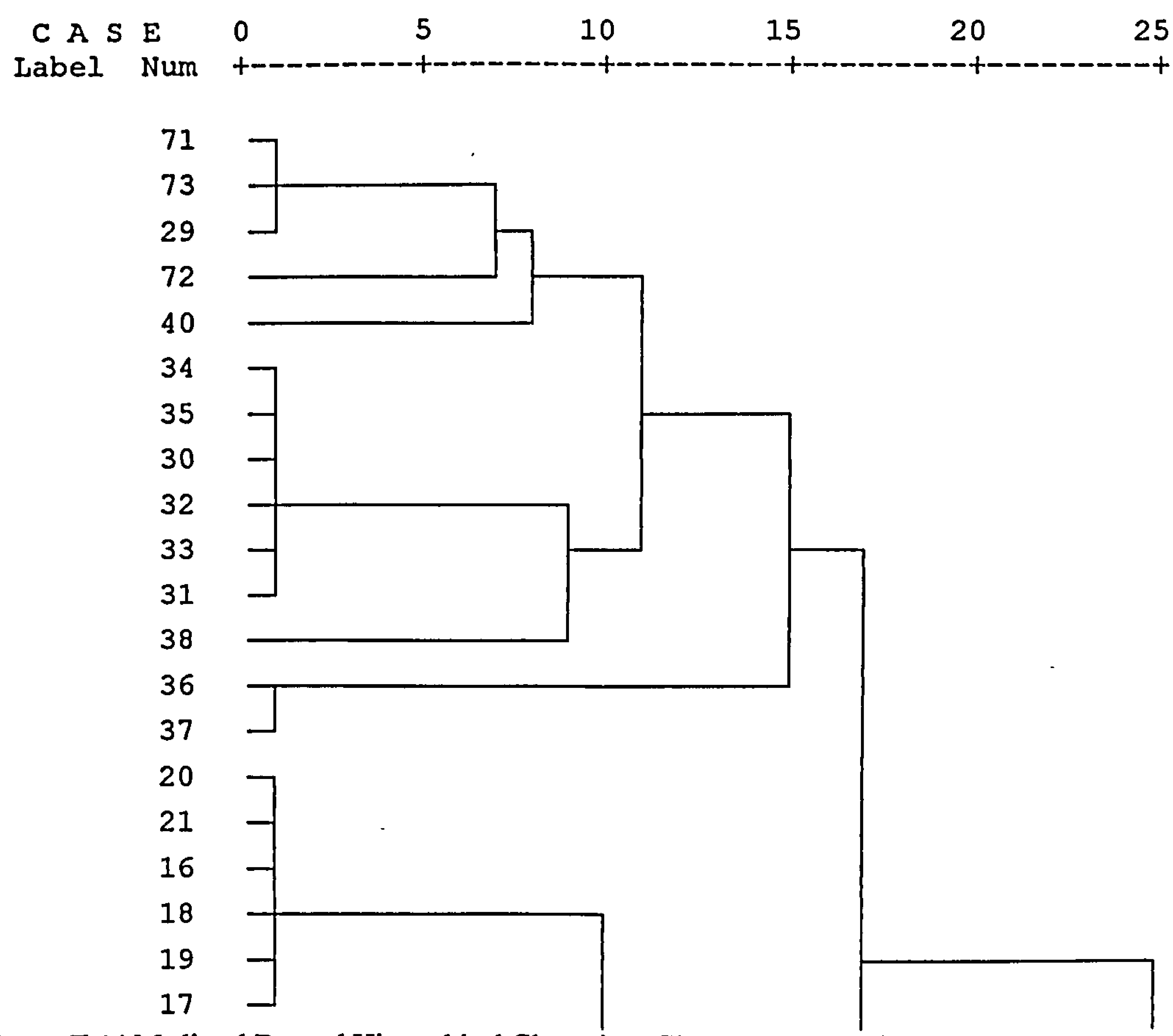
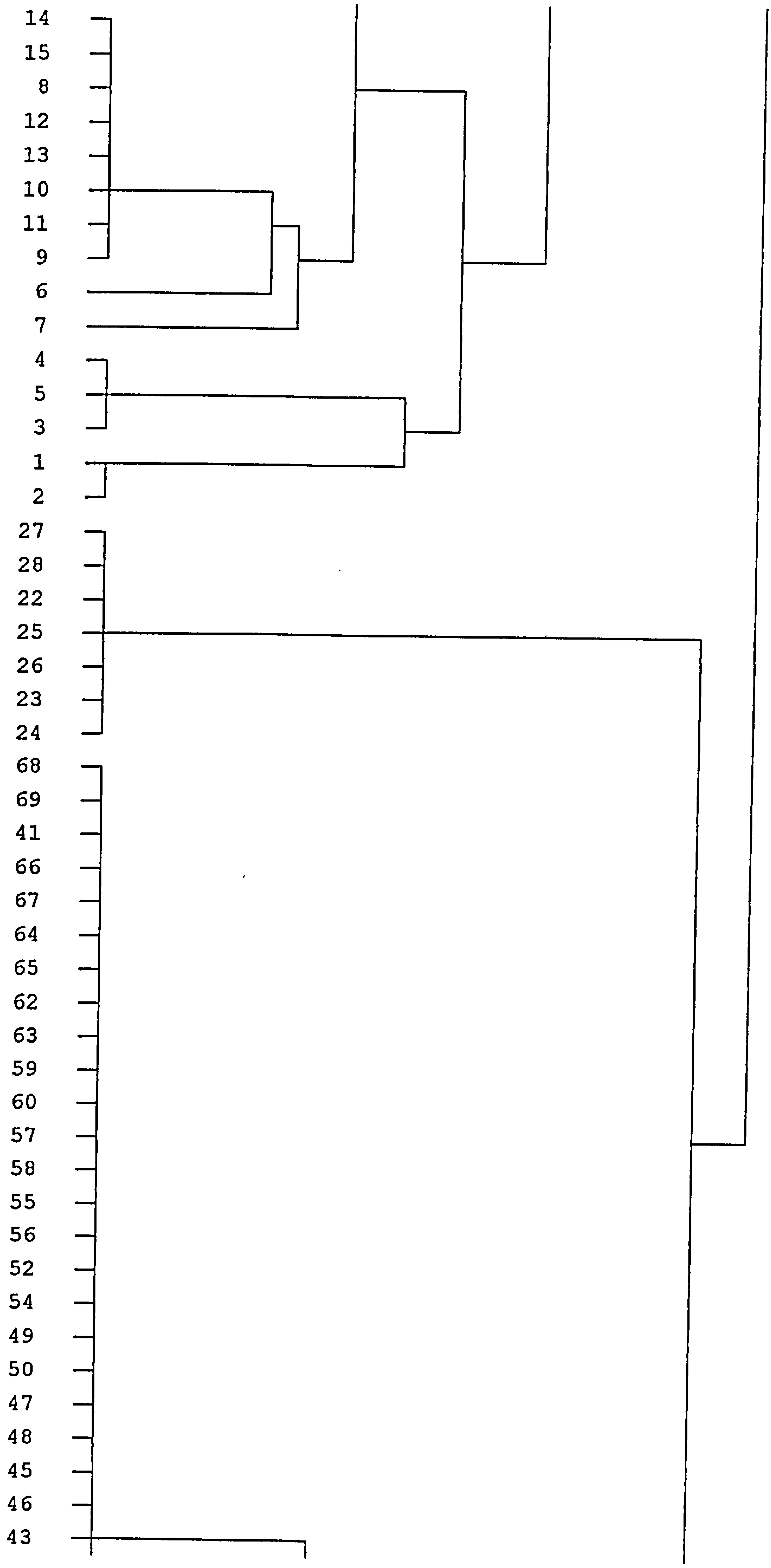



**Figure F.14** Medieval Data - 1 Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure


14
15
8
12
13
10
11
9
6
7
4
5
3
1
2
27
28
22
25
26
23
24
68
69
41
66
67
64
65
62
63
59
60
57
58
55
56
52
54
49
50
47
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46
43

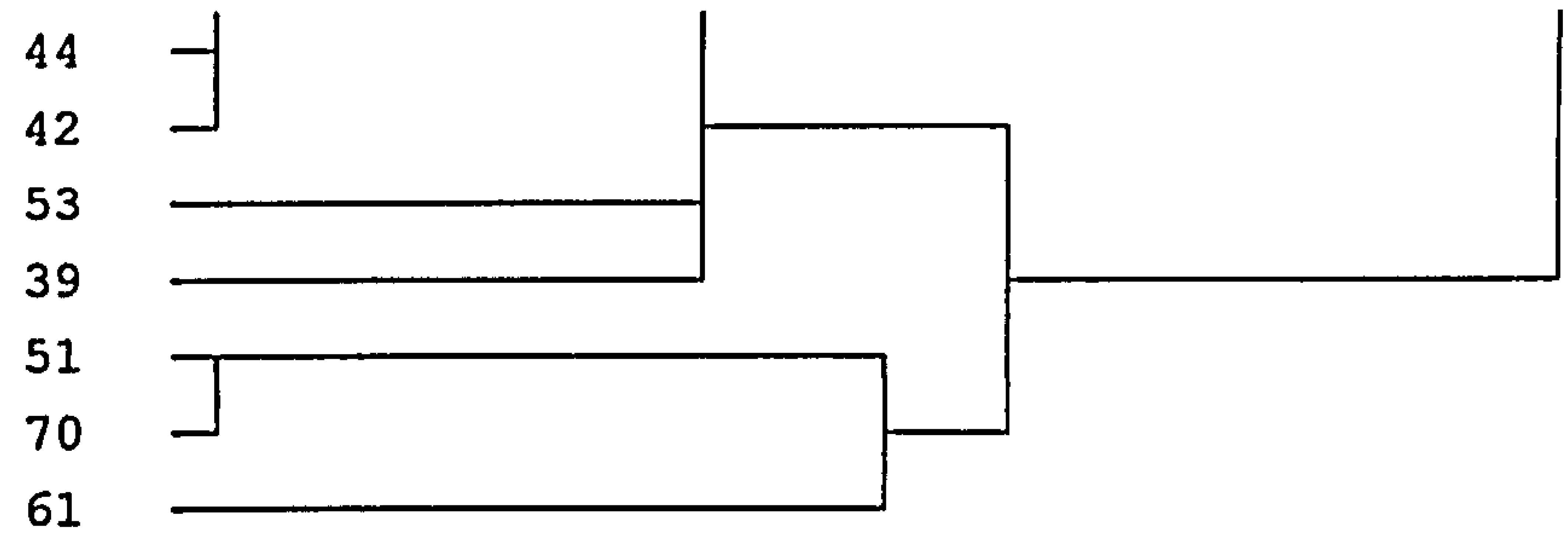


**Figure F.14** Medieval Data - I Hierarchical Clustering: Cluster membership 2-5; Between-group Average; Jaccard Measure (con't.)

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | 0 | 1 | 0 |
| CONTAIN | 0 | 0 | 0 |
| CODCR | 1 | 0 | 1 |
| CODN | 0 | 0 | 0 |
| MUT | 1 | 0 | 1 |
| GG | 0 | 0 | 0 |
| BODPOSIT | 1 | 1 | 0 |
| MISC | 0 | 0 | 0 |
| CEMTYPE | 1 | 1 | 0 |
| MARKER | 0 | 0 | 0 |

**Table F.46** Medieval Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Final Cluster Centers**

| | Cluster | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| STATUS | Military | Civilian | Military |
| CONTAIN | No | No | No |
| CODCR | Yes | No | Yes |
| CODN | No | No | No |
| MUT | Yes | No | Yes |
| GG | No | No | No |
| BODPOSIT | Norm | Norm | No |
| MISC | No | No | No |
| CEMTYPE | Perm | Perm | Temp |
| MARKER | No | No | No |

**Table F.47** Medieval Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 4.000 |
| | 2 | 31.000 |
| | 3 | 38.000 |
| Valid | | 73.000 |
| Missing | | .000 |

**Table F.48** Medieval Data - K-means Clustering: Cluster membership 3; Squared Euclidean distance

# APPENDIX G – COMMANDS USED IN SOMTOOLBOX FOR MATLAB

One example of all the MATLAB command line syntax for creating and visualising a SOM of a dataset as represented in Chapter 6: Application and Results of the SOM Neural Network (% denotes comment regarding the command (for more detail on these commands and comments see Vesanto et al. 2000)).

## G.1 Spain Commands

```
sD=som_read_data('Spain.data')
      % Reads data from an ascii file.

sTop=som_topol_struct('data',sD)
      % Topology struct contains values for map size, lattice
      % (default is 'hexa') and shape default is 'sheet'). Map size
      % depends on training data and the number of map units. The
      % number of map units depends on the number of training
      % samples.

sMap = som_make(sD)
      % SOM_MAKE Create, initialize and train Self-Organizing Map

sMap = som_autolabel(sMap,sD,'vote')
      % This function automatically labels given map/data struct
      % based on an already labelled data/map struct.

colormap(1-gray)
      % 'colormap'(matrix) user defined colormap
som_show(sMap,'norm','d')
      % Shows basic visualizations of SOM: component planes, unified
      % distance matrices as well as empty planes and fixed colour
      % planes.
som_show(sMap,'umat','all','empty','Labels')
      % Show U-matrix ('umat') value defines the variables to be
      % used for calculating a u-matrix.
som_show_add('label',sMap,'Textsize',8,'TextColor','r','Subplot',2)
      % U-matrix is shown on the left, and an empty grid named
      % 'Labels' is shown on the right.

bmus = som_bmus(sMap,sD)
      % SOM_BMUS Find the best-matching units from the map for the
      % given vectors
h = som_hits(sMap,sD)

som_show_add('hit',h,'MarkerColor','b','Subplot',1)
      % The SOM_SHOW function makes the basic visualization of the
      % SOM. With SOM_SHOW_ADD one can set labels, hit histograms or
      % different trajectories on this visualization.

som_show_clear('hit',1)
      % This function removes the objects made by SOM_SHOW_ADD from
      % a figure.  It simply searches for the objects with
      % certain values in the 'Tag' field.

h1 = som_hits(sMap,sD.data(1:11,:));
      % SOM_HITS Calculate the response of the given data on the map
h2 = som_hits(sMap,sD.data(12:34,:));
h3 = som_hits(sMap,sD.data(35:68,:));
som_show_add('hit',[h1, h2, h3],'MarkerColor',
```

```
[1 0 0; 0 1 0; 0 0 1],'Subplot',1)
      % Multiple hit histograms can be shown simultaneously. Three
      % hit histograms corresponding to three sites of the five is
      % calculated and shown.

U = som_umat(sMap);
      % som_umat: Compute unified distance matrix of self-organizing
      % map
Um = U(1:2:size(U,1),1:2:size(U,2))

Colormap(1-gray)
som_show(sMap,'umat','all')
sMap = som_autolabel(sMap,sD,'vote');
som_show_add('label',sMap,'Textsize',8,'TextColor','r')

som_show_clear('hit',1)

subplot(1,2,1)
h=som_cplane(sMap, Um(:));
      % Creates some basic visualizations of the SOM grid: the
      % component plane and the unified distance matrix.
set(h,'Edgecolor','none'); title('D-matrix (grayscale)')
      % D-Matrix -  median distance matrix (with grayscale)

subplot(1,2,2)
som_cplane(sMap,'none',1-Um(:)/max(Um(:)))
title('D-matrix (marker size)')
      % D-Matrix - median distance matrix (with map unit size)

som_show_clear('hit',1)

Colormap(1-gray)
som_order_cplanes(sMap)
      % SOM_ORDER_CPLANES Orders and shows the SOM component planes
colormap(1-gray)
subplot(1,2,1)
h=som_cplane([sMap.topol.lattice,'U'],sMap.topol.msize, U(:));
set(h,'Edgecolor','none'); title('U-matrix')

subplot(1,2,2)
som_order_cplanes(sMap)
colormap(1-gray)
som_show(sMap,'umat','all','comp',[5:6,8:9],'norm','d')
som_show_add('label',sMap.labels,'textsize',8,'textcolor','r',
'subplot',5)

som_show_clear('hit',1)

colormap(1-gray)
som_show(sMap,'umat','all')
h = som_hits(sMap,sD);
som_show_add('label',sMap.labels,'textsize',8,'textcolor','r',
'subplot',1)

som_show_clear('hit',1)

colormap(1-gray)
som_show(sMap,'comp',[8 9],'umat',{8:9,'8,9 only'},'umat','all')
      % Show 8-9. Component planes 8 and 9 (variables 'Eight' and
      % 'Nine')
      % U-matrix that is calculated only using variables
```

```
      % 'Eight' and 'Nine' with title '8,9 only'
      % U-matrix that is calculated using all variables with the
      % default title 'U-matrix'
som_show_add('label',sMap.labels,'textsize',8,'textcolor','r',
'subplot',3)


sD=som_read_data('Spain2.data')

sTop=som_topol_struct('data',sD)

sMap = som_make(sD)

sMap = som_autolabel(sMap,sD,'vote')

colormap(1-gray)
som_show(sMap,'norm','d')

colormap(1-gray)
som_show(sMap,'umat','all','empty','Labels')
som_show_add('label',sMap,'Textsize',8,'TextColor','r','Subplot',2)

bmus = som_bmus(sMap,sD)
h = som_hits(sMap,sD);

som_show_clear('hit',1)

h1 = som_hits(sMap,sD.data(1:11,:));
h2 = som_hits(sMap,sD.data(12:34,:));
h3 = som_hits(sMap,sD.data(35:68,:));
som_show_add('hit',[h1, h2, h3],'MarkerColor',
[1 0 0; 0 1 0; 0 0 1],'Subplot',1)
```

# Appendix H – Numbering System and Records Used in SPSS and MATLAB

## H.1 All Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1124 | 1 | 1121 | 47 | 42 | 93 | 1234 | 139 |
| 1126 | 2 | 1122 | 48 | 31 | 94 | 1237 | 140 |
| 1128 | 3 | 1123 | 49 | 334 | 95 | 1250 | 141 |
| 1131 | 4 | 1125 | 50 | 1170 | 96 | 1251 | 142 |
| 1132 | 5 | 1127 | 51 | 1171 | 97 | 1256 | 143 |
| 1134 | 6 | 1129 | 52 | 1172 | 98 | 1267 | 144 |
| 1137 | 7 | 1130 | 53 | 1173 | 99 | 302 | 145 |
| 1138 | 8 | 1133 | 54 | 1174 | 100 | 1186 | 146 |
| 1205 | 9 | 1135 | 55 | 1175 | 101 | 1187 | 147 |
| 1208 | 10 | 1136 | 56 | 1176 | 102 | 1188 | 148 |
| 1210 | 11 | 1228 | 57 | 1177 | 103 | 1190 | 149 |
| 1211 | 12 | 1229 | 58 | 1178 | 104 | 1191 | 150 |
| 1213 | 13 | 1230 | 59 | 1179 | 105 | 1192 | 151 |
| 1214 | 14 | 1231 | 60 | 1180 | 106 | 1193 | 152 |
| 1215 | 15 | 1232 | 61 | 1181 | 107 | 1194 | 153 |
| 1221 | 16 | 1233 | 62 | 1140 | 108 | 1195 | 154 |
| 1222 | 17 | 1206 | 63 | 1141 | 109 | 1196 | 155 |
| 1226 | 18 | 1207 | 64 | 1142 | 110 | 1197 | 156 |
| 5 | 19 | 1209 | 65 | 1143 | 111 | 1198 | 157 |
| 12 | 20 | 1212 | 66 | 1144 | 112 | 1199 | 158 |
| 13 | 21 | 1216 | 67 | 1145 | 113 | 1200 | 159 |
| 14 | 22 | 1217 | 68 | 1146 | 114 | 1235 | 160 |
| 15 | 23 | 1218 | 69 | 1147 | 115 | 1236 | 161 |
| 17 | 24 | 1219 | 70 | 1148 | 116 | 1238 | 162 |
| 18 | 25 | 1220 | 71 | 1149 | 117 | 1239 | 163 |
| 19 | 26 | 1223 | 72 | 1150 | 118 | 1240 | 164 |
| 20 | 27 | 1224 | 73 | 1151 | 119 | 1241 | 165 |
| 21 | 28 | 1225 | 74 | 1152 | 120 | 1242 | 166 |
| 23 | 29 | 1227 | 75 | 1153 | 121 | 1243 | 167 |
| 26 | 30 | 6 | 76 | 1154 | 122 | 1244 | 168 |
| 28 | 31 | 7 | 77 | 1155 | 123 | 1245 | 169 |
| 30 | 32 | 8 | 78 | 1156 | 124 | 1246 | 170 |
| 32 | 33 | 9 | 79 | 1157 | 125 | 1247 | 171 |
| 33 | 34 | 10 | 80 | 1158 | 126 | 1248 | 172 |
| 34 | 35 | 11 | 81 | 1159 | 127 | 1249 | 173 |
| 36 | 36 | 16 | 82 | 1160 | 128 | 1252 | 174 |
| 38 | 37 | 22 | 83 | 1161 | 129 | 1253 | 175 |
| 333 | 38 | 24 | 84 | 1162 | 130 | 1254 | 176 |
| 335 | 39 | 25 | 85 | 1163 | 131 | 1255 | 177 |
| 1182 | 40 | 27 | 86 | 1164 | 132 | 1257 | 178 |
| 1183 | 41 | 29 | 87 | 1165 | 133 | 1258 | 179 |
| 1184 | 42 | 35 | 88 | 1166 | 134 | 1259 | 180 |
| 1185 | 43 | 37 | 89 | 1167 | 135 | 1260 | 181 |
| 1203 | 44 | 39 | 90 | 1189 | 136 | 1261 | 182 |
| 1204 | 45 | 40 | 91 | 1201 | 137 | | |
| 1120 | 46 | 41 | 92 | 1202 | 138 | | |

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1262 | 183 | 53 | 235 | 115 | 287 | 201 | 339 |
| 1263 | 184 | 54 | 236 | 116 | 288 | 203 | 340 |
| 1264 | 185 | 55 | 237 | 117 | 289 | 204 | 341 |
| 1265 | 186 | 56 | 238 | 118 | 290 | 205 | 342 |
| 1266 | 187 | 57 | 239 | 119 | 291 | 206 | 343 |
| 301 | 188 | 58 | 240 | 120 | 292 | 207 | 344 |
| 303 | 189 | 59 | 241 | 123 | 293 | 208 | 345 |
| 304 | 190 | 60 | 242 | 124 | 294 | 209 | 346 |
| 305 | 191 | 61 | 243 | 125 | 295 | 210 | 347 |
| 306 | 192 | 62 | 244 | 126 | 296 | 211 | 348 |
| 307 | 193 | 63 | 245 | 127 | 297 | 212 | 349 |
| 308 | 194 | 64 | 246 | 128 | 298 | 213 | 350 |
| 309 | 195 | 65 | 247 | 131 | 299 | 214 | 351 |
| 310 | 196 | 66 | 248 | 133 | 300 | 215 | 352 |
| 311 | 197 | 67 | 249 | 134 | 301 | 216 | 353 |
| 312 | 198 | 68 | 250 | 135 | 302 | 217 | 354 |
| 313 | 199 | 69 | 251 | 136 | 303 | 218 | 355 |
| 314 | 200 | 70 | 252 | 137 | 304 | 219 | 356 |
| 315 | 201 | 71 | 253 | 138 | 305 | 220 | 357 |
| 316 | 202 | 73 | 254 | 139 | 306 | 221 | 358 |
| 317 | 203 | 74 | 255 | 140 | 307 | 222 | 359 |
| 318 | 204 | 76 | 256 | 141 | 308 | 223 | 360 |
| 319 | 205 | 77 | 257 | 142 | 309 | 224 | 361 |
| 320 | 206 | 78 | 258 | 143 | 310 | 225 | 362 |
| 321 | 207 | 80 | 259 | 144 | 311 | 226 | 363 |
| 322 | 208 | 81 | 260 | 145 | 312 | 227 | 364 |
| 323 | 209 | 82 | 261 | 146 | 313 | 228 | 365 |
| 324 | 210 | 84 | 262 | 147 | 314 | 229 | 366 |
| 325 | 211 | 85 | 263 | 148 | 315 | 230 | 367 |
| 326 | 212 | 86 | 264 | 149 | 316 | 231 | 368 |
| 327 | 213 | 88 | 265 | 150 | 317 | 232 | 369 |
| 328 | 214 | 91 | 266 | 151 | 318 | 233 | 370 |
| 329 | 215 | 92 | 267 | 152 | 319 | 234 | 371 |
| 330 | 216 | 93 | 268 | 153 | 320 | 235 | 372 |
| 331 | 217 | 94 | 269 | 154 | 321 | 236 | 373 |
| 332 | 218 | 95 | 270 | 155 | 322 | 237 | 374 |
| 336 | 219 | 97 | 271 | 156 | 323 | 239 | 375 |
| 338 | 220 | 98 | 272 | 157 | 324 | 240 | 376 |
| 339 | 221 | 99 | 273 | 158 | 325 | 241 | 377 |
| 340 | 222 | 100 | 274 | 159 | 326 | 242 | 378 |
| 341 | 223 | 101 | 275 | 160 | 327 | 243 | 379 |
| 342 | 224 | 102 | 276 | 161 | 328 | 244 | 380 |
| 43 | 225 | 104 | 277 | 162 | 329 | 245 | 381 |
| 44 | 226 | 105 | 278 | 191 | 330 | 246 | 382 |
| 45 | 227 | 106 | 279 | 192 | 331 | 247 | 383 |
| 46 | 228 | 108 | 280 | 193 | 332 | 248 | 384 |
| 47 | 229 | 109 | 281 | 194 | 333 | 249 | 385 |
| 48 | 230 | 110 | 282 | 195 | 334 | 250 | 386 |
| 49 | 231 | 111 | 283 | 197 | 335 | 251 | 387 |
| 50 | 232 | 112 | 284 | 198 | 336 | 337 | 388 |
| 51 | 233 | 113 | 285 | 199 | 337 | 72 | 389 |
| 52 | 234 | 114 | 286 | 200 | 338 | 75 | 390 |

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 79 | 391 | 130 | 402 | 171 | 413 | 184 | 424 |
| 83 | 392 | 132 | 403 | 172 | 414 | 185 | 425 |
| 87 | 393 | 196 | 404 | 173 | 415 | 186 | 426 |
| 89 | 394 | 202 | 405 | 176 | 416 | 188 | 427 |
| 90 | 395 | 238 | 406 | 177 | 417 | 189 | 428 |
| 96 | 396 | 164 | 407 | 178 | 418 | 190 | 429 |
| 103 | 397 | 165 | 408 | 179 | 419 | 163 | 430 |
| 107 | 398 | 166 | 409 | 180 | 420 | 169 | 431 |
| 121 | 399 | 167 | 410 | 181 | 421 | 174 | 432 |
| 122 | 400 | 168 | 411 | 182 | 422 | 175 | 433 |
| 129 | 401 | 170 | 412 | 183 | 423 | 187 | 434 |

## H.2 All Conflict Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 5 | 75 | 1127 | 87 | 1176 | 109 | 1222 | 145 |
| 6 | 76 | 1128 | 88 | 1177 | 110 | 1223 | 146 |
| 7 | 77 | 1129 | 16 | 1178 | 111 | 1224 | 147 |
| 8 | 78 | 1130 | 17 | 1179 | 112 | 1225 | 73 |
| 9 | 79 | 1131 | 18 | 1180 | 113 | 1226 | 148 |
| 10 | 80 | 1132 | 19 | 1181 | 114 | 1227 | 149 |
| 11 | 37 | 1133 | 20 | 1182 | 29 | 1228 | 32 |
| 12 | 81 | 1134 | 21 | 1183 | 48 | 1229 | 150 |
| 13 | 82 | 1135 | 22 | 1184 | 30 | 1230 | 151 |
| 14 | 51 | 1136 | 23 | 1185 | 31 | 1231 | 152 |
| 15 | 52 | 1137 | 24 | 1186 | 115 | 1232 | 153 |
| 16 | 1 | 1138 | 42 | 1187 | 116 | 1233 | 154 |
| 17 | 38 | 1140 | 89 | 1188 | 117 | 1234 | 155 |
| 18 | 53 | 1141 | 90 | 1189 | 118 | 1235 | 156 |
| 19 | 54 | 1142 | 25 | 1190 | 119 | 1236 | 157 |
| 20 | 55 | 1143 | 91 | 1191 | 120 | 1237 | 158 |
| 21 | 56 | 1144 | 92 | 1192 | 121 | 1238 | 159 |
| 22 | 57 | 1145 | 26 | 1193 | 122 | 1239 | 160 |
| 23 | 58 | 1146 | 93 | 1194 | 123 | 1240 | 161 |
| 24 | 83 | 1147 | 94 | 1195 | 124 | 1241 | 162 |
| 25 | 59 | 1148 | 95 | 1196 | 125 | 1242 | 163 |
| 26 | 60 | 1149 | 96 | 1197 | 126 | 1243 | 164 |
| 27 | 39 | 1150 | 43 | 1198 | 127 | 1244 | 165 |
| 28 | 40 | 1151 | 97 | 1199 | 128 | 1245 | 166 |
| 29 | 2 | 1152 | 98 | 1200 | 129 | 1246 | 167 |
| 30 | 61 | 1153 | 99 | 1201 | 130 | 1247 | 168 |
| 31 | 183 | 1154 | 44 | 1202 | 131 | 1248 | 169 |
| 32 | 84 | 1155 | 27 | 1203 | 132 | 1249 | 74 |
| 33 | 62 | 1156 | 45 | 1204 | 133 | 1250 | 170 |
| 34 | 3 | 1157 | 46 | 1205 | 68 | 1251 | 171 |
| 35 | 4 | 1158 | 47 | 1206 | 134 | 1252 | 172 |
| 36 | 85 | 1159 | 63 | 1207 | 69 | 1253 | 173 |
| 37 | 5 | 1160 | 64 | 1208 | 135 | 1254 | 174 |

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 38 | 86 | 1161 | 65 | 1209 | 136 | 1255 | 175 |
| 39 | 41 | 1162 | 28 | 1210 | 137 | 1256 | 176 |
| 40 | 6 | 1163 | 100 | 1211 | 140 | 1257 | 177 |
| 41 | 7 | 1164 | 101 | 1212 | 141 | 1258 | 178 |
| 42 | 8 | 1165 | 102 | 1213 | 70 | 1259 | 50 |
| 1120 | 9 | 1166 | 66 | 1214 | 138 | 1260 | 179 |
| 1121 | 10 | 1167 | 67 | 1215 | 139 | 1261 | 33 |
| 1122 | 11 | 1170 | 103 | 1216 | 49 | 1262 | 180 |
| 1123 | 12 | 1171 | 104 | 1217 | 71 | 1263 | 181 |
| 1124 | 13 | 1172 | 105 | 1218 | 142 | 1264 | 34 |
| 1125 | 14 | 1173 | 106 | 1219 | 143 | 1265 | 182 |
| 1126 | 15 | 1174 | 107 | 1220 | 72 | 1266 | 35 |
| | | 1175 | 108 | 1221 | 144 | 1267 | 36 |

## H.3 Spain Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 218 | 15 | 1234 | 22 | 235 | 57 | 1251 | 38 |
| 219 | 7 | 1235 | 23 | 236 | 58 | 1252 | 40 |
| 220 | 16 | 1236 | 24 | 237 | 59 | 1253 | 41 |
| 221 | 50 | 1237 | 25 | 238 | 1 | 1254 | 42 |
| 222 | 9 | 1238 | 26 | 239 | 60 | 1255 | 43 |
| 223 | 51 | 1239 | 27 | 240 | 61 | 1256 | 39 |
| 224 | 13 | 1240 | 28 | 241 | 62 | 1257 | 44 |
| 225 | 52 | 1241 | 29 | 242 | 63 | 1258 | 45 |
| 226 | 17 | 1242 | 30 | 243 | 20 | 1259 | 6 |
| 227 | 53 | 1243 | 32 | 244 | 64 | 1260 | 46 |
| 228 | 54 | 1244 | 33 | 245 | 65 | 1261 | 3 |
| 229 | 55 | 1245 | 34 | 246 | 66 | 1262 | 47 |
| 230 | 18 | 1246 | 35 | 247 | 21 | 1263 | 48 |
| 231 | 8 | 1247 | 36 | 248 | 67 | 1264 | 4 |
| 232 | 19 | 1248 | 37 | 249 | 14 | 1265 | 49 |
| 233 | 56 | 1249 | 12 | 250 | 68 | 1266 | 5 |
| 234 | 10 | 1250 | 31 | 251 | 11 | 1267 | 2 |

## H.4 Korea Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1140 | 1 | 1160 | 21 | 176 | 42 | 197 | 63 |
| 1141 | 2 | 1161 | 22 | 177 | 43 | 198 | 64 |
| 1142 | 3 | 1162 | 23 | 178 | 44 | 199 | 65 |
| 1143 | 4 | 1163 | 24 | 179 | 45 | 200 | 66 |
| 1144 | 5 | 1164 | 25 | 180 | 46 | 201 | 67 |
| 1145 | 6 | 1165 | 26 | 181 | 47 | 202 | 68 |
| 1146 | 7 | 1166 | 27 | 182 | 48 | 203 | 69 |
| 1147 | 8 | 1167 | 28 | 183 | 49 | 204 | 70 |
| 1148 | 9 | 163 | 29 | 184 | 50 | 205 | 71 |

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1149 | 10 | 164 | 30 | 185 | 51 | 206 | 72 |
| 1150 | 11 | 165 | 31 | 186 | 52 | 207 | 73 |
| 1151 | 12 | 166 | 32 | 187 | 53 | 208 | 74 |
| 1152 | 13 | 167 | 33 | 188 | 54 | 209 | 75 |
| 1153 | 14 | 168 | 34 | 189 | 55 | 210 | 76 |
| 1154 | 15 | 169 | 35 | 190 | 56 | 211 | 77 |
| 1155 | 16 | 170 | 36 | 191 | 57 | 212 | 78 |
| 1156 | 17 | 171 | 37 | 192 | 58 | 213 | 79 |
| 1157 | 18 | 172 | 38 | 193 | 59 | 214 | 80 |
| 1158 | 19 | 173 | 39 | 194 | 60 | 215 | 81 |
| 1159 | 20 | 174 | 40 | 195 | 61 | 216 | 82 |
| | | 175 | 41 | 196 | 62 | 217 | 83 |

## H.5 Balkans Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1170 | 1 | 1203 | 30 | 103 | 60 | 133 | 90 |
| 1171 | 2 | 1204 | 31 | 104 | 61 | 134 | 91 |
| 1172 | 3 | 75 | 32 | 105 | 62 | 135 | 92 |
| 1173 | 4 | 76 | 33 | 106 | 63 | 136 | 93 |
| 1174 | 5 | 77 | 34 | 107 | 64 | 137 | 94 |
| 1175 | 6 | 78 | 35 | 108 | 65 | 138 | 95 |
| 1176 | 7 | 79 | 36 | 109 | 66 | 139 | 96 |
| 1177 | 8 | 80 | 37 | 110 | 67 | 140 | 97 |
| 1178 | 9 | 81 | 38 | 111 | 68 | 141 | 98 |
| 1179 | 10 | 82 | 39 | 112 | 69 | 142 | 99 |
| 1180 | 11 | 83 | 40 | 113 | 70 | 143 | 100 |
| 1181 | 12 | 84 | 41 | 114 | 71 | 144 | 101 |
| 1186 | 13 | 85 | 42 | 115 | 72 | 145 | 102 |
| 1187 | 14 | 86 | 43 | 116 | 73 | 146 | 103 |
| 1188 | 15 | 87 | 44 | 117 | 74 | 147 | 104 |
| 1189 | 16 | 88 | 45 | 118 | 75 | 148 | 105 |
| 1190 | 17 | 89 | 46 | 119 | 76 | 149 | 106 |
| 1191 | 18 | 90 | 47 | 120 | 77 | 150 | 107 |
| 1192 | 19 | 91 | 48 | 121 | 78 | 151 | 108 |
| 1193 | 20 | 92 | 49 | 122 | 79 | 152 | 109 |
| 1194 | 21 | 93 | 50 | 123 | 80 | 153 | 110 |
| 1195 | 22 | 94 | 51 | 124 | 81 | 154 | 111 |
| 1196 | 23 | 95 | 52 | 125 | 82 | 155 | 112 |
| 1197 | 24 | 96 | 53 | 126 | 83 | 156 | 113 |
| 1198 | 25 | 97 | 54 | 127 | 84 | 157 | 114 |
| 1199 | 26 | 98 | 55 | 128 | 85 | 158 | 115 |
| 1200 | 27 | 99 | 56 | 129 | 86 | 159 | 116 |
| 1201 | 28 | 100 | 57 | 130 | 87 | 160 | 117 |
| 1202 | 29 | 101 | 58 | 131 | 88 | 161 | 118 |
| | | 102 | 59 | 132 | 89 | 162 | 119 |

## H.6 19th Century North America Data

| *REMID* | SPSS *Case* | *REMID* | SPSS *Case* | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 1120 | 1 | *1205* | *24* | *1228* | *47* | *53* | *70* |
| 1121 | 2 | 1206 | 25 | 1229 | 48 | 54 | 71 |
| 1122 | 3 | 1207 | 26 | 1230 | 49 | 55 | 72 |
| 1123 | 4 | 1208 | 27 | 1231 | 50 | 56 | 73 |
| 1124 | 5 | 1209 | 28 | 1232 | 51 | 57 | 74 |
| 1125 | 6 | 1210 | 29 | 1233 | 52 | 58 | 75 |
| 1126 | 7 | 1214 | 30 | 336 | 53 | 59 | 76 |
| 1127 | 8 | 1215 | 31 | 337 | 54 | 60 | 77 |
| 1128 | 9 | 1211 | 32 | 338 | 55 | 61 | 78 |
| 1129 | 10 | 1212 | 33 | 339 | 56 | 62 | 79 |
| 1130 | 11 | 1213 | 34 | 340 | 57 | 63 | 80 |
| 1131 | 12 | 1216 | 35 | 341 | 58 | 64 | 81 |
| 1132 | 13 | 1217 | 36 | 342 | 59 | 65 | 82 |
| 1133 | 14 | 1218 | 37 | 43 | 60 | 66 | 83 |
| 1134 | 15 | 1219 | 38 | 44 | 61 | 67 | 84 |
| 1135 | 16 | 1220 | 39 | 45 | 62 | 68 | 85 |
| 1136 | 17 | 1221 | 40 | 46 | 63 | 69 | 86 |
| 1137 | 18 | 1222 | 41 | 47 | 64 | 70 | 87 |
| 1138 | 19 | 1223 | 42 | 48 | 65 | 71 | 88 |
| 1182 | 20 | 1224 | 43 | 49 | 66 | 72 | 89 |
| 1183 | 21 | 1225 | 44 | 50 | 67 | 73 | 90 |
| 1184 | 22 | 1226 | 45 | 51 | 68 | 74 | 91 |
| 1185 | 23 | 1227 | 46 | 52 | 69 | | |

## H.7 Medieval Data

| REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case | REMID | SPSS Case |
|---|---|---|---|---|---|---|---|
| 5 | 1 | 24 | 20 | 301 | 39 | 319 | 57 |
| 6 | 2 | 25 | 21 | 302 | 40 | 320 | 58 |
| 7 | 3 | 26 | 22 | 303 | 41 | 321 | 59 |
| 8 | 4 | 27 | 23 | 304 | 42 | 322 | 60 |
| 9 | 5 | 28 | 24 | 305 | 43 | 323 | 61 |
| 10 | 6 | 29 | 25 | 306 | 44 | 324 | 62 |
| 11 | 7 | 30 | 26 | 307 | 45 | 325 | 63 |
| 12 | 8 | 31 | 27 | 308 | 46 | 326 | 64 |
| 13 | 9 | 32 | 28 | 309 | 47 | 327 | 65 |
| 14 | 10 | 33 | 29 | 310 | 48 | 328 | 66 |
| 15 | 11 | 34 | 30 | 311 | 49 | 329 | 67 |
| 16 | 12 | 35 | 31 | 312 | 50 | 330 | 68 |
| 17 | 13 | 36 | 32 | 313 | 51 | 331 | 69 |
| 18 | 14 | 37 | 33 | 314 | 52 | 332 | 70 |
| 19 | 15 | 38 | 34 | 315 | 53 | 333 | 71 |
| 20 | 16 | 39 | 35 | 316 | 54 | 334 | 72 |
| 21 | 17 | 40 | 36 | 317 | 55 | 335 | 73 |
| 22 | 18 | 41 | 37 | 318 | 56 | | |
| 23 | 19 | 42 | 38 | | | | |

**H.8 Remains Records** (Identification based on original Access numbering system)

To identify case number referred to in Chapters 5 and 6; locate appropriate numbering system for test results (e.g. section H.3 for Spain only data Case 15 = REMID 218) to convert case number to REMID.

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 13 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 44 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 45 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 46 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 47 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 48 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 49 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 50 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 51 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 52 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 53 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 54 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 55 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 56 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 57 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 58 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 59 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 60 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 61 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 62 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 64 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 65 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 66 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 67 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 68 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 69 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 70 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 71 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 72 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 73 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 74 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 75 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 76 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 77 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 78 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 79 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 80 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 81 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 82 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 83 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 84 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 85 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 86 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 87 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 88 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 89 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 90 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 91 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 92 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 93 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 94 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 96 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 97 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 98 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 99 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 100 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 101 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 102 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 103 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 104 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 105 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 106 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 107 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 108 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 109 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 110 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 111 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 112 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 113 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
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| 115 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 116 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 117 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 118 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 119 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 120 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 121 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 122 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 123 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 124 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 125 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 126 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |

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| 127 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 128 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 129 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 130 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 131 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 132 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 133 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 134 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 135 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 136 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 137 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 138 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 139 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
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| 141 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 142 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 143 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 144 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 145 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 146 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 147 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 148 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 149 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 150 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 151 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 152 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 153 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 154 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 155 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 156 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 157 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 158 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |

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| 159 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 160 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 161 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 162 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 163 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 164 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 165 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 166 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 167 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 168 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 169 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 170 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 171 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 172 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 173 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 174 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 175 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 176 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 177 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 178 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 179 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 180 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 181 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 182 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 183 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 184 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 185 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 186 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 187 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 188 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 189 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 190 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |

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| 191 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 192 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 193 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 194 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 195 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 196 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 197 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 198 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 199 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
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| 201 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
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| 203 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
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| 205 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 206 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 207 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 208 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 209 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 210 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 211 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 212 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 213 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 214 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 215 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 216 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 217 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 218 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 219 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 220 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 221 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 222 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |

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| 223 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 224 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 225 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 226 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 227 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 228 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 229 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 230 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 231 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 232 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 233 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 234 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 235 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 236 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 237 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 238 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 239 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 240 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 241 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 242 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 243 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 244 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 245 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 246 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 247 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 248 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 249 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 250 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 251 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 301 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 302 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 303 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

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| 304 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 305 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 306 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 307 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 308 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 309 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 310 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 311 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 312 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 313 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 314 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 315 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 316 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 317 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 318 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 319 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 320 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 321 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 322 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 323 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 324 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 325 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 326 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 327 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 328 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 329 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 330 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 331 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 332 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 333 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 334 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 335 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

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| 336 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 337 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 338 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
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| 340 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 341 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 342 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1120 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1121 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1122 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1123 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1124 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1125 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1126 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1127 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1128 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1129 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1130 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1131 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1132 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1133 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1134 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1135 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1136 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1137 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1138 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1140 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1141 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1142 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1143 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1144 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1145 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |

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| 1146 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1147 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1148 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 1149 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 1150 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1151 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1152 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1153 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1154 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1155 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1156 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1157 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1158 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1159 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1160 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1161 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1162 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1163 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1164 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1165 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1166 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1167 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1170 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1171 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1172 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1173 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1174 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1175 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1176 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1177 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1178 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1179 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1180 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1181 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1182 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1183 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1184 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1185 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1186 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1187 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1188 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1189 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1190 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1191 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1192 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1193 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1194 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1195 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1196 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1197 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1198 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1199 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1200 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1201 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1202 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1203 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1204 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1205 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1206 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1207 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1208 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1209 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1210 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1211 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1212 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1213 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1214 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1215 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1216 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1217 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1218 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1219 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1220 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1221 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1222 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1223 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1224 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1225 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1226 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1227 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1228 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1229 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1230 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1231 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1232 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1233 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1234 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1235 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1236 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1237 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1238 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1239 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1240 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1241 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1242 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1243 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

| REMID | STATUS | CONTAIN | CODCR | CODEJ | CODSD | CODN | MUT | MARKER | CLOTH | GG | BODPOS | MISC | CEMTYP | OBINT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1244 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1245 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1246 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1247 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1248 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1249 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1250 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1251 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1252 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1253 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1254 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1255 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1256 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1257 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1258 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1259 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1260 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1261 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1262 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1263 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1264 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1265 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1266 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1267 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |

# THESIS CONTAINS CD/DVD