6. The Enigmatic Handaxe: in search of idiosyncrasies in bifacial technology through three-dimensional form

Frederick W. F. Foulds

Abstract

Palaeolithic archaeology has experienced a dramatic shift from processual to post-processual theory in recent years. As a result we have begun to adjust our focus from interpreting the roles of groups of hominids to investigating the way in which 'individual' hominins had an impact on their societies. While some argue for a 'bottom-up' approach to the study of the Palaeolithic (Gamble & Gittens 2004), others are of the opinion that the study of 'individual' hominins is a goal beyond the resolution of the Palaeolithic archaeological record (e.g. Clark 1992). Perhaps more problematic is the current lack of a methodological framework that allows us to test our theoretical assumptions and interpret the social aspect of material culture beyond mere 'naïve reconstructionism' (Hopkinson & White 2005). With lithic assemblages being our most celebrated source of evidence for Palaeolithic societies, this paper presents the results from a new and innovative experiment that seeks to show whether these artefacts can be attributed to the individuals who made them. Using three-dimensional reconstruction of tool forms and a reflexive method of interpreting the data, this attempts to test the validity of the 'bottom-up' approach in a step towards new analytical techniques that may ask, and answer, new questions of Palaeolithic material culture.

Introduction

The discipline of archaeology has been approached from various different perspectives throughout time; from the culture history of the late 19th and early 20th centuries, though the New Archaeology of the 1960s and into the Post-Processual archaeology of the last few decades (Trigger 2006). This final shift from studying the material record using highly scientific and evolutionary processes to a more socially orientated approach produced numerous conflicts throughout the archaeological community (Rowley-Conwy 2001). However, as the papers presented in this volume show, archaeologists are beginning to put the Processual versus Post-Processual debates behind them (see also Millson 2011). Instead, they are now striving towards methods of analysis that combine science and theory in a reciprocal fashion. Not least amongst these approaches has been the use of experimental archaeology, through which theories can be tested and new hypotheses formed. This brings about a cyclical approach, whereupon a constant discourse is created that builds our understanding of the past. Employing such an experimental approach, this paper questions the possibility of the study of the individual and its behaviour, a common goal amongst theoretical archaeologists (e.g. Dobres 2000; Hodder 1982). Focusing explicitly on the Palaeolithic, which has only recently come under the scrutiny of social theorists, a series of experiments were carried out using this period's most prevalent form of evidence; stone tools. Although focusing on a specific part of the archaeological record, it is hoped that this will spark new debates amongst both Palaeolithic archaeologists, as well as archaeological theorists. To begin with though, it is prudent to review the theoretical shift in Palaeolithic studies in order to provide some background to these experiments.

Social Archaeology and the Palaeolithic

Theoretical approaches to Palaeolithic archaeology, especially that of the Lower and Middle Palaeolithic, became rather stagnant towards the turn of the 21st century and it was not until the last decade that the social perspective of the post-processual school has truly been applied to this period. Instead, archaeologists tended to concentrate upon highly processual analytical techniques, focusing on evolutionary and adaptive explanations for variability in the material record (Gamble & Gittins 2004). The reason for this reluctance to join in with these new methods of analysis is perhaps because the available data is not considered to be rich enough for studies of social agency and the behaviour of the individual (Wobst 2000). In fact, the study of the individual was said to be an impossible goal for Palaeolithic archaeologists (Gamble 1998a), as the actions of such individuals are beyond the resolution of the available record (Clark 1992, 107). Therefore, groups of hominins have remained the base level of analysis in studies of the Palaeolithic (Clark 1992; Gamble 1998a; Gamble & Gittins 2004; Gamble & Porr 2005b), whilst archaeologists studying later prehistoric periods strived towards the study of the individual actor and their impact upon society.

As the study of agency and individual behaviour slowly began to creep into the interpretation of the Palaeolithic archaeological record, it appeared to be confined to discussions of the Upper Palaeolithic (e.g. Dobres 2000; Grimm 2000; Mithen 1991; 1993; Pigeot 1990; Sinclair 2000). Perhaps due to the suite of behavioural changes taken to occur at this time, such as fully modern language (Lieberman 1989; 1992; 2007), a brain capable of modern thought

(Dunbar 2003; Mithen 1996) and the appearance of 'out of brain' symbolic storage (Wadley 2001), the Upper Palaeolithic was more amenable to these approaches. As a consequence, the Lower and Middle Palaeolithic have been disconnected from this theoretical stance until relatively recently. In a step towards changing this, Gamble (Gamble 1998a, b; 1999; 2004; 2007; Gamble & Gittins 2004; Gamble & Porr 2005a) has stressed that archaeologists need to adapt their interpretations of the Palaeolithic record to a "bottom-up" approach that deals with individual decision making and its effect on social and economic strategies. This in turn has led to a number of recent papers being published that turn away from the traditional approaches given to Lower and Middle Palaeolithic archaeology in favour of more socially orientated techniques that study individual hominins and their agency (e.g. papers in Gamble & Porr 2005b; Gravina 2004). However, while advances are being made in the application of social theory to Palaeolithic contexts, there are still those who insist that we lack a methodological framework that allows the social aspect of material culture to be interpreted beyond what Hopkinson and White (2005, 27) have termed "naïve reconstructionism".

The Processual Individual?

Although the study of individuals has only recently become the focus of many inquiries into Palaeolithic material culture, the idea that the lone hominid should be the base element of any discussion is not a new theoretical view. Bradley and Sampson (1986) reminded archaeologists that the variability seen in artefacts begins with the individual, whilst earlier still Gunn (1975; 1977) suggested a possible methodology for studying individuals through final tool form. However, these studies were more concerned with style and its separation from function in attempts to explain variation in terms of adaptive measures, evolutionary processes and the internal organisation of social systems, rather than inquiring about social relationships (Barrett 1988; Dunnell 1978; Jones 1997). Stylistic variation was seen as a signature of ethnic difference that stood apart from functional characteristics (Binford 1962; 1965), which were intended to render the contents of the past in sensible terms (Dunnell 1978). This approach led to individual behaviour being reduced to idiosyncrasy and creativity (Shanks & Tilley 1987), meaning that the deeper social meaning that was inextricably linked to such variability was passed over.

The dichotomy between style and function was later critiqued by Sackett (1977; 1982; 1985), who suggested style was an inherent attribute linked to choice, while the functional element remained the same. Therefore, instead of style being separate to function, they go hand in hand. Sackett also posited that this *isochrestic variation* was principally derived from and prescribed by culture; in essence suggesting that a correlation with ethnicity could be formed (Jones 1997). However, Sackett's view of style has been questioned by Lemmonier (1992, 89-91), who states that this "does not tell us anything about the…means for communicating social information". Instead, the only function that may be attributed to *isochrestic style* is observations on possible adaptive advantages of particular shapes (*ibid.*, 90). Jones (1997) also went on to suggest that this explaination of variation is more akin to a congealed representation of Bourdieu's (1990) *habitus*. Under these terms, the relationship between an individual's identity and the material culture that they create is inaccessible.

More recent research has begun to move beyond these approaches into the realms of the decisions and motivations that drove artefact construction (e.g. Schlanger 1994; 1996), combining this with the study of social agency in attempts to break the barrier that previous studies imposed and form more socially orientated approaches to material culture. Artefacts are now seen as more than extraneous to human life and analysis has begun to move beyond the Westernised idea of tools as disconnected from the social sphere (Pfaffenberger 1988). As a result, technology has become linked to the larger social constructs that materialise through its use, and current techniques attempt to investigate material culture using this knowledge in order to dissect the social relationships embodied within.

Agency and the Individual

With the realisation that variation in artefacts can be interpreted in an endless number of ways (Lemonnier 1992), and that people negotiated their world through social and material interaction combined, the concept of social agency has become central to the archaeologist's study of material culture (Dobres & Robb 2000). Technology is now seen as a "total social fact" (Schlanger 1990, 22), a product of human choices and social phenomena (Pfaffenberger 1988, 239). Through the use of technology, individuals actively fashioned their worlds (Winner 1986, 14-15) and themselves through the social relations and experiences created by its use (Dobres 2000; Dobres & Robb 2000; Gosden 1999; Pfaffenberger 1988).

Again, such notions had been put forward in previous incarnations of archaeological thought. Despite such statements being part of the study of systems that these new concepts criticised, Childe (1956) suggested that the expressions of human thought and ideas were embodied in the artefacts we recover, while Binford (1962) stressed links between individual social processes and material culture. Redman (1977) also pointed out that, by using the smallest analytical unit available, archaeologists could begin to unravel how individuals contributed to wider social change. However, due to the focus on empirical observations of the available record, the role of agency and the analysis of individual agents became trapped in what has been termed a "black box" (Dobres 2000; Dobres & Robb 2000).

What is true of the study of agency and the aims of the post-processualist school is the narrowing of the analytical ideal to the individual agent and how sociality was formed from individual events (Hodder 2000). By analysing these events, such as refitting knapped flint (e.g. Grimm 2000; Pigeot 1990; Schlanger 1996), we have the possibility of reconstructing evidence of an individual's agency and how this affected and was affected by social relations and society at large. But is it enough to identify individuals within what Roe (1980) has termed "precise moments in time", such as knapping sequences? If we believe Hodder (2000), the isolation of such events prevents us from truly understanding how individuals involved themselves with the social structures that surrounded them. In other words, while we may be able to talk of what one individual might have done, we are still unable to extrapolate this to other individuals and, from there, the wider social whole.

There are yet more problems with the analysis of individuals. Moore (2000, 260) has stated that we cannot substitute evidence of agency for evidence of the individual. Also, the notion of the individual has been criticised as a heavily Western influenced concept. Thomas (2004) has emphasised the study of how relationships sustained people, rather than base our analysis on the presumption that the individual is the core of all social matters. This has been complicated further by the idea that persons can perceive themselves not as individuals, but as part of a greater system of fluid relationships (see Busby 1997). Chapman (2000; Chapman & Gaydarska 2006) has taken this idea of partible persons and used it in the creation of a methodology that interprets the fragmentation and accumulation of objects as links between people and their material culture in attempts to explore such relationships. From this perspective, the individual becomes 'dividual' and a person can be seen as constructed from social relationships as opposed to their own individual experiences (Knapp & van Dommelen 2008, 16).

If we then accept that we cannot translate the archaeological record according to our modern concepts of individualism then, as Moore (2000) states, we can no longer associate the agency producing actor with the individual. We can conceive that specific persons created the material culture that we excavate, but we are unable to fully understand how these agents thought of themselves (Knapp & van Dommelen 2008, 17). Yet we still need to obtain a better resolution of social actors, as they are "intimately implicated in maintaining and transforming social structures, values and practices" (*ibid.*). By tracing the actions of a single specific entity in the material record, one may begin to reconstruct the relationships between the actor, their material culture and the wider society in which they belong.

Some have argued that the study of agency should not devolve into attempts to trace specific actors (Dobres 2000; Dobres & Robb 2000; Redman 1977; Sassaman 2000). Instead, the focus should be on actions that can be clearly seen in the physical evidence that is left behind (Sinclair 2000), which can be seen as created through conscious and unconscious decisions that influence social bonds and for the *habitus* of daily life (Bourdieu 1990; Giddens 1979). However, I would argue that this approach does not allow for such social bonds to be explored and disconnects the action from the actor, thus removing the actor from the social relations we wish to study, and which they are an integral part of. If agency is used in the creation of an actor's identity, which in turn is constructed from that actor's experiences, constrained by the larger social whole and expressed through their material culture (Bourdieu 1990; Giddens 1979), does this not mean that they should be the focus of our study as opposed to simply the actions they make? If we understand the problem in this way, the actor becomes a "world within the world" (Bourdieu 1990, 56); a social construct that is aligned with the greater 'society', but formed from its own specific relationships and experiences (contra Knapp & van Dommelen 2008). They become contained within society, but are also separate from it at the same time. Therefore, the study of the single agent, the action that they produce and how this relates to the actions performed by other agents within the social network, as opposed to a study of action in general, can be said to be useful, as it would allow for a greater understanding of social relationships and the perception of identity.

The Palaeolithic Individual?

As has already been mentioned, several studies have already been conducted that centre on the individual in the Palaeolithic. Here it must be noted that the word individual is used to refer not to the Westernised concept of a bounded self, but to the single actor removed from the issue of their concept of personhood. This is a term that will continue to be used through the remainder of this chapter and must not be misconstrued. In a similar way these previous studies spoke of individuals, yet can be interpreted as referring to single social actors, rather than beings that conceived of themselves in a specific way. However, while these studies acknowledge that variability in material culture began with the actions of individuals (e.g. Bradley & Sampson 1986; Gunn 1975; 1977), their focus was on behavioural and ecological concerns. The focus on the social aspect of the material record has been a more recent development for Palaeolithic archaeology.

Mithen (1990; 1991) was one of the earliest to pursue the interaction of individuals in the Palaeolithic. However, his focus was upon the 'generic' individual and was more interested in individual decisions, rather than decisions made by individuals (Bahn 1991). Concepts such as memory, information and planning were taken as implicit markers of cognitive action and, therefore, individuals (Mithen 1993, 395), where the individual is understood as the smallest unit within the group. Mithen (*ibid*.) was forced to agree with Clark (1992) that tracing individuals in the Palaeolithic was impossible outside of rare events, such as refitting tools and cave paintings. Later studies began to contemplate the specific individual in greater depth by further investigating these unique phenomena.

One prominent author has been Schlanger (1990), who noted that techniques are tied to social life. Although such ties are often intangible, Schlanger went on to show that through the act of any technique the social aspect of that technique is expressed. Each gesture used correlates to choices, assessments and decisions made by the individual in the generation of knowledge that is finally embodied within the finished artefact (Schlanger 1994). He then went on to demonstrate the "interplay between mental and material activities" in the production of Levallois flakes (Schlanger 1996), illustrating that the reduction process involved a "fluid articulation of knowledge…rather than [being] hard-wired and thoughtless" (Gravina 2004). Sadly, Schlanger did not relate these processes to the social conditions surrounding how actors "negotiated between material contingency and individual intentions, skills and knowledge, [or] how such tricks of the trade were learned and passed on" (Dobres 2000, 184).

One other area of research that has made some progress towards the introduction of actors to the analysis of Palaeolithic technology has been the study of apprenticeship, such as at the Magdalenian site of Etoilles, France (Pigeot 1990). Pigeot (*ibid*., 126) acknowledges that art and burial are areas in which the individual is clearly expressed, but stresses that these appear as distorted reflections of society. On the other hand, lithic tools and their use are habitual elements of the Palaeolithic, and through the knapping process the expression of the knapper is inscribed with each percussive act. Through the analysis of these actions, the aims of the individual involved can be analysed and differences in knapping skill can be demonstrated. This has also been illustrated at other Palaeolithic sites (Grimm 2000; Stapert 2007) and the suggestion that differences in knapping skill reflects evidence of experts and novices has been postulated as a result. This has important implications as processes of learning not only begin to engender actors within the past, but also bring our understanding of technical knowledge back to a habitual and heuristic sphere that enables the study of agency through technology to occur almost seamlessly (Sinclair 2000). However, the one problem with these studies is that, while individuals and their actions are studied, it appears to be generalisations about the group as a whole that encompasses the resultant discussion. Hence the individual becomes lost within the group, rather than remaining as the focus of analysis.

Gamble (2004) has proposed a way around problems such as these, acknowledging the fact that sociality resides in the objects that form hominin cultures and that these should be the focus for the study of socially extended interactions. Stating that the Palaeolithic archaeologists attempting to overcome these hurdles do not currently have an adequate methodology for the study of artefacts in terms of the social and individual (*ibid*., 20), Gamble proposed the use of Chapman's (2000) fragmentation hypothesis. However, initial attempts to apply the concepts of fragmentation and enchainment in the analysis of carcass butchery at Saltzgitter-Lebenstedt (Gamble & Gaudzinski 2005) did little more than show how hominins were gathering tools and carcasses at specific points in the landscape, rather than provide a movement towards the analytical ideal of the 'bottom-up' approach.

Gamble has continued to pursue the idea of accumulation and enchainment in the formulation of identity in the Palaeolithic (Gamble 2007). Although it has been said that language is the device through which an individual gains identity (Shanks & Tilley 1987, 65), the concept of agency in the creation and modification of social ties through material culture means that the Palaeolithic is the starting point for material interference between individuals and their worlds (Wobst 2000). In this case, hominins have always been concerned with the construction of identity (Gamble 2007, 166), even prior to the emergence of fully modern language. However, there are notable problems with Gamble's approach to the study of identity. While I do not contest the idea that material culture has an inherent role in the formulation of identity, Gamble's use of material culture as a proxy for the body through which social relations are formed is flawed. It can be easily accepted that groups of objects can provide links in chains of relations, yet this approach appears to be moving our interpretations from the basis of the hominin group to groups of accumulated objects. Therefore, we are switching our analysis from one group to another, while the individual remains lost within the theoretical melee.

Unfortunately, Gamble's notion of the *childscape* is another application that can be shown to have inherent problems. Although it recognises the fact that childhood is the time when much of an individual's identity is formed (Shanks & Tilley 1987, 64-65), the *childscape* is hidden from us. This is a point that Gamble readily accepts (2007, 229), but suggests that the *childscape* can be though of as "continually created and reproduced" through the experiences formed from material culture, meaning that the evidence for its existence (and thus the notion of identity) can be seen in the accumulation, fragmentation and consumption of artefacts that enchained relationships throughout the child's world (*ibid*., Chapter 8). However, this proposition is more to do with a way of thinking about the archaeology, rather than providing an actual methodology that allows us to explicitly unravel such relationships. Therefore, the individual and their identity is once more swallowed by metaphor and rhetoric designed to promote thought and understanding rather than analysis (White 2008).

While fragmentation, accumulation and enchainment are important elements that should not be ignored in Palaeolithic research, the current lack of a methodology that allows the individual to be isolated, coupled with the broad tool cultures that span large geographical and temporal regions, limits the use of this hypothesis. Where it is most useful is in the explicit analysis of those sites that show inter-site refitting. However, demonstrating that such refits can be correlated to enchained relationships produced through the exchange of flint artefacts is much more difficult. In such situations, a single individual or groups of individuals could have produced these tools, removing the theory of inter-site relationships between different actors, but allowing us to consider hominin movements through localised areas. On the other hand, tools may originate from temporally different periods, meaning that we cannot rule out whether knapping occurred in one instant, or was extended over a greater period of time. Indeed, we cannot even rule out the possibility that raw materials were discarded by one individual and later picked up and rejuvenated by another! To pries apart this tangle of possibilities, it would be prudent to focus on tracing the actions of the individual in order to follow the spread of the material culture they create before we can discuss the relations that this dispersal then creates.

To Analyse the individual…

The question that remains is how does one go about turning what is almost 'theoretical storytelling' into a methodology that can be applied to Palaeolithic contexts? What are the traits through which an individual might be traced? And, most importantly of all, where does one begin? The focus of such a methodology could be the art, burial and ritual evidence that are commonly used as markers for identity, but the most prominent problem with this would be the limited timeframe in which these occur. Most instances of this evidence seen in Palaeolithic contexts are confined to the Upper, and possibly Middle Palaeolithic (for discussion see Gargett 1989; 1999; Hayden 1993; Pettitt 2000; Pettitt & Schumann 1993). Also, as Pigeot (1990) reminds us, burial is a contentious issue for teasing apart the issue of identity. Those who organise the interment bury the grave good, not the deceased individual. This then limits us to the social behaviour surrounding inhumation, rather than the wider relationships that Gamble (2007) wishes to discuss. In a similar way, art has been used to explore social organisation (Balme & Morse 2006; Vanhaeren & d'Errico 2005) and individual behaviour (Henshilwood & d'Errico 2005; Mithen 1991; Sharpe & van Gelder 2006), but these are limited to isolated events that lead to theoretical musings, rather than allowing for relational links to be established. Therefore, a methodology that deals with the habitual, day-to-day life-ways of hominins must be found, one that does not limit analysis to a specific genus or timescale.

The obvious choice for the Palaeolithic archaeologist is found in the stone tools that hominins used, which represent the main constituent of Palaeolithic assemblages (Roe 1980, 108). As mentioned above, previous studies have approached lithic artefacts through refitting in order to answer questions of individual behaviour and identity (Pigeot 1990; Pope 2004; Pope & Roberts 2005; Schlanger 1996). Of course, this appears to be the most appropriate method of analysis due to the investigation of the acts and goals that are fossilised in each knapping sequence and has already been explored, with some success (Foulds 2010). However, one must strive to move beyond such isolated moments in time. To do this, a wider study must be conducted that aims to separate the individual's imprint from the other forms of variation seen in formal tools. If this is a possibility, the flow of relationships between individuals at archaeological sites in primary context may be considered in greater depth, which in turn will provide a broader picture of the exchange and enchainment of identity through material means. However, such a method cannot be applied and tested upon Palaeolithic contexts, where the individuals who created the tools we excavate are unknown to us. In such cases, each tool may be seen as the product of a separate individual, thus representing a single hominin and providing little information about their role in the creation of identity. As a consequence, the use of experimental archaeology is a viable alternative, where the individual knappers of the tools examined can be known and one can assess not only whether the individual's imprint can be seen in a tool, but also if that imprint can be traced across other tools and differentiated from the impressions of other actors.

The Experiment

We are now left with the question Gamble (1998a) posed over a decade ago; how do you unlock the social information contained within a stone tool? The answer is to look for those idiosyncrasies in tools and their manufacture that may be linked to the individual who created them. In doing so, it is important to return to earlier studies of the individual in material culture. Although they have been criticised by the post-processualists, who baulked at the notion of scientific interpretations and the explanation of variability in terms of adaptation and economics (Rowley-Conwy 2001), these studies form the grounds for a more social study of the individual through material culture. They have shown that diversity in tools is not only a result of raw material and design, but also the individual knapper's skill and technique, resulting in subconscious variation produced by differences in motor habits (Bradley & Sampson 1986; Hill & Gunn 1977). This implies that an individual's skill or idiosyncratic style in producing lithic artefacts might be traced, something that has been attempted through both experimental and archaeological means (Gunn 1975; 1977; McGhee 1980; Tomka 1989). These studies thus show the possibility for grouping tools according to the individuals who created them.

From these previous studies there are two routes that may lead to an approach that allows the individual element in stone tools to be ascertained and analysed. The first is to use lithic refitting, a method that Foulds (2010) has already examined. The second is through the analysis of the final form of the finished tool, as suggested by Gunn (1975). To explore the possibilities for studying the individual and tracing their idiosyncratic signatures through tools, a series of three experiments was devised:

1. Platform preparation. Some knappers prepare platforms prior to flake removal, while others do not. This may be an indicator of skill.
2. Analysis of refitting sequences and recording those traits that can be attributed to the individual (see Foulds 2010).
3. Investigation of idiosyncratic elements in the three-dimensional form of the finished tool.
4. Examining the orientation of two-dimensional scar patterns that are left upon the surface of the finished tool (after Gunn 1975).

The second of these forms the main focus of this paper.

Approaching the individual

In his paper, "Idiosyncratic Behaviour in Chipping Style", Gunn (1975) identified eight possible indicators of idiosyncratic knapping traits. These traits include:

5. Platform preparation. Some knappers prepare platforms prior to flake removal, while others do not. This may be an indicator of skill.
6. Flake scar orientation. This may vary due to the technique used by the individual knapper, the way they rotate and work around the blank. However, the early stages of removal are less likely to reflect this fact (see below).
7. Bulb of percussion. Knapping technique may result in differences in the depth and definition of the bulbar area
8. Undulations or ‘ripple marks’. Again, these may vary in size according to the force used in the removal.
9. Termination. Variation in flake termination can result from raw material properties, but also from the abilities of the individual knapper.
10. Accuracy. Miss-hits, resulting in crushed platforms and hinge fractures, can differentiate one knapper from another who is able to cleanly strike the edge that is being worked.
11. Striking angle. The angle at which the hammer stone meets the raw material can vary from one individual to another.
12. The thickness of the removal. Knappers may produce thick or thin flakes depending upon the way that they approach the removal of raw material.

These eight traits can be applied to refitting sequences, but they may also allow for finished tools to be examined in a similar way. As noted in the second of these features, the initial reduction of the raw material used to produce a tool is often unplanned (Bradley & Sampson 1986) and often takes place near raw material sources (e.g. at Boxgrove, see Pope 2004; Pope & Roberts 2005). Instead, it is the later stages of the knapping sequence where the knapper applies greater thought to the removal of the flakes that shape the finished product (Andrefsky 2005, 187-8). In the case of the experimental analysis of Acheulian handaxe manufacture, this process makes up roughly fifty percent of the debitage, while the final shaping of the biface results in a further ten percent. This is of paramount importance, as it indicates that the faces of such implements are apt to contain the highest levels of the individual’s choices.

With the wide variety of reduction techniques and tools presented by the Palaeolithic record, there is an inevitable need to focus on one specific technology in order to test whether the individual can be traced via these traits. Therefore, the experiments that make up this analysis were conducted using Acheulian handaxes. The reason for this choice is twofold. Firstly, this attempts to push the boundaries of individual analysis beyond the Upper Palaeolithic and, secondly, to test whether this approach is viable when applied to the deepest prehistoric contexts.

As a consequence of the limitations of the archaeological record previously mentioned, the experiments had to be carried out through the use of replicated tools, resulting in the creation of an experimental assemblage. Although the replication of techniques, such as those used in these experiments, is not necessarily the same as replicating the actual technology (Dobres 2000), the potential for individuals to be traced through the idiosyncrasies they leave behind in stone tools under experimental conditions may result in the same being possible for archaeological samples. In addition, testing the methodology by experimental means allows for it to be refined and its response to the available data to be improved upon, prior to any application to actual artefacts. This will, in turn, enable knapping experience and its use in archaeological interpretations to be critiqued in a reflexive manner.

An experimental assemblage

To create the assemblage used for the experimental analysis presented here, six knappers (labelled 1 through 6) were requested to produce a total of 26 handaxes, which were randomly sorted and numbered. No restraints were placed over the knappers' choice of raw material, technique or individual style. The knappers thus produced handaxes according to their own skill, mood and the properties of the chosen raw materials. Therefore, an almost organic assemblage was produced that provided as close a substitute for an archaeological assemblage as was feasibly possible. The result was a range of handaxe forms produced by each individual, which also allowed for the possibility of examining whether technique surpasses overall shape. Additionally, in order to test the analytical method under conditions that are closely aligned to those experienced in archaeological investigations, the identities of the knappers remained secret throughout the experiments. This resulted in a blind test mechanic being implemented, which prevented the results from being interpreted using the known values of which knapper created which tool, while at the same time simulating the problems that would be inherent in the analysis of a Palaeolithic sample. The outcome of this approach was that the results of the analysis could subsequently be compared to the known relationships between tools and creators, allowing the conclusions drawn from these results to be proven true or false.

The analysis of three-dimensional form

Data acquisition

In an attempt to build upon Gunn's (1975) technique, it was decided that an exploration of three-dimensional form, and its possible relation to the individual's technique and skill, should be implemented alongside the study of refitting sequences and two-dimensional scar patterns. To achieve this, the assemblage was modelled in three-dimensions in order to produce a complete record of the surface of each handaxe. This was accomplished using a Mephisto Complete optical scanner (4D Dynamics, release 1.8.0202), which can achieve accuracies of up to 0.06mm. The scanning process produced point-clouds made up of coordinates in three-dimensions (Figure 6.1). This technique was applied to each of the 26 tools in the experimental assemblage, generating a separate scan for each face of the handaxes. On occasion, multiple scans of a handaxe were needed, which could then be combined. This was often the case with pointed or atypically shaped tools.

Figure 6.1. Example of the point-cloud produced by the scanning technique displayed in three dimensions. The handaxe in this image is number 11.

Overall this resulted in a total of 52 scans being produced. These scans were then processed using Demon 3D (Archaeoptics, release 1.5.2) in order to remove any erroneous points. In addition, each of the scans was orientated as if on a north-south axis, with the tip of the handaxe being the northernmost point and the butt placed at the south, in order to ensure that the data was comparable across the entire assemblage. The data was then imported into the ArcMap package within ArcGIS (ESRI, version 9.3). Using this software, the point-cloud data was converted into a raster format, allowing it to be treated in the same way as a landscape. The Spatial Analyst Tool for analysing aspect was then used to assign each point with the 52 point-clouds a value in degrees related to its orientation of slope. These values represented the eight cardinal directions; North (0°-22.5° and 337.5°-360°), North East (22.5°-67.5°), East (67.5°-112.5°), South East (112.5°-157.5°), South (157.5°-202.5°), South West (202.5°-247.5°), West (247.5°-292.5°) and finally North West (292.5°-337.5°). The number of points within each of these variables was calculated and then converted into a percentage value in order to standardise the data. This conversion was necessary due to variation in the number of points within each point-cloud, a factor that was influenced by the size of each handaxe and whether the data was formed from an amalgamation of several scans. In a similar way, the Slope program within the Spatial Analyst Tools was used to explore the gradient between points within the scans. Again, each point was assigned a value in degrees. However, in this approach the variables used to allocate points were created using five-degree increments between zero (flat) and ninety degrees (perpendicular). An example of the graphical output of this technique is shown in Figure 6.2.

Figure 6.2. Visual representation of aspect (left) and slope (right) data, as produced by ArcMap. The handaxe in this image is number 1.

In addition to the analysis of the surfaces of each handaxe, it was also deemed important to approach each tool as a whole. Therefore, the data from each face was summed for each pair of handaxe surfaces. This resulted in new percentage values for each variable that reflected the totality of points recorded across each tool.

Statistical analysis

Once the data had been acquired, it was then subjected to statistical analysis using a mixture of principal components and cluster techniques. This analysis was performed with the SPSS statistics package for Windows (SPSS 17, release 17.0.0). Principal components analysis was performed on all sets of data through the use of the SPSS program FACTOR. No rotation was applied to the data during the analysis. Following this, cluster analysis was conducted on the resultant principal component data. In this case, the SPSS HEIRARCHICAL CLUSTER program was used. This program aims to divide the data into distinct groups. The results of this process were then mapped onto the principal component data and are discussed below.

Results

Analysis of Aspect Data

Table 6.1. Results from the principal component analysis applied to the aspect data for individual handaxe surfaces.

The results from the principal components analysis applied to the aspect data from the handaxe surfaces are presented in Table 6.1. As this table shows, three components were extracted with eigenvalues that were greater than 1.0, which accounted for 68.52% of the total variation within the dataset. The first of these components was comprised of variation in the South East, South and South West directions, while the second component was made up of North and North East orientations. The final component was also mainly composed of variation in North orientation, although there may have been slight influences from points orientated in a North West direction. From these results it appears that the majority of variation originates from differences in the size of the butt and also the tip of the handaxes. In reflection, this can be explained quite straightforwardly. Pointed handaxes will naturally have a narrower tip, resulting in fewer points recorded for this area. Also, due to the pointed nature of these bifaces, there are likely to be fewer points recorded for the butt area when compared to ovate handaxes, which show a much more curved shape. Therefore, it appears that the results of this analysis tell us more about the shape of the tool, rather than the traits reflecting individual idiosyncrasy that the experiment was searching for.

Table 6.2. Results from the principal component analysis applied to the aspect data for whole axes.

The same process was applied to the results obtained from the axes as whole units. Again, three main components were obtained, accounting for 73.06% of the variation (Table 6.2). As shown in the results achieved by treating each surface individual, the first of these components displays variation amongst the South East, South and South West variables. Component two is composed of variation in points assigned to North and North West categories, while component three is solely attributed to variation in North East orientation. Once more, this reveals that the shape of the handaxes accounts for the majority of the variation, resulting in the imprint of the individual knapper being hidden.

Figure 6.3. Principal component analysis of aspect data for individual handaxe surfaces. Surfaces are labelled "T" for top and "B" for bottom. The top graph displays an example of the cluster analysis results, using six unique clusters. The bottom graph displays the actual values of knappers involved in the experiment.

Figure 6.4. Principal component analysis of aspect data for handaxes treated as wholes. Handaxes are individually numbered. The top graph displays an example of the cluster analysis results, using six unique clusters. The bottom graph displays the actual values of knappers involved in the experiment.

Once the principal component analysis was completed, the results were plotted using scatter diagrams. Cluster analysis was then applied to the principal component data in an attempt to cluster the results into groups. The results of the cluster analysis were then mapped onto the scatter diagrams in order to explore the meaning behind the proposed clusters. These were then compared to the known values of the knappers to see if the technique was able to succeed in separating out the individuals involved (see Figures 6.3 and 6.4). As can be seen in both sets of graphs, the cluster analysis was unable to attribute handaxes to their creators. Again, it appears that the analyses of aspect reveals more about the butt and tip shape, as opposed to idiosyncrasies that are related to the individual imprint. Also of note is the fact that in the scatter diagram showing the relationships between handaxe surfaces, the tops and bottoms of the same axe often do not group together. This may indicate that the knapper's approach to each face of the handaxe is subtly different, leading to variation in knapping strategy that creates this dissimilarity. However, the extent to which this is true remains to be seen.

Analysis of Slope Data

Table 6.3. Results from the principal component analysis applied to the slope data for individual handaxe surfaces.

Results from the principal component analysis of the slope data applied to the handaxe surfaces are displayed in Table 6.3. Four main components with eigenvalues of 1.0 or above were extracted from the analysis, representing 89.42% of the overall variation. Of these components, the first is comprised of the variation in all increments between 25° and 85°. The second component shows variation in only those increments between 70° and 85°, while the third component is made up of variation in between 15° and 25°. The final component shows variation in the highest category, namely the five degree increment between 85° and 90°. Of these components, the fourth component has possibly been introduced by handaxe 26, which shows a high degree of points with steep slope values. This is due to a perpendicular removal along the edge of the butt (Figure 6.5). This would also account for the reason the top face of this axe appears to be an outlier in the scatter diagrams (see Figure 6.6).

Figure 6.5. Photograph of handaxe 26. Note the fracture on the left edge of the butt. This has produced a very steep and flat surface along the edge of the tool.

Table 6.4. Results from the principal component analysis applied to the slope data for whole tools.

Principal components analysis was also applied to the slope data from the analysis of the axes as wholes. The results from this analysis are displayed in Table 6.4. Three components were extracted from this data, accounting for 85.72% of the variation. Component one is similar to that produced by the handaxe surfaces, being made up of variation in the increments between 25° and 75°, as well as the five degree increment between 80° and 85°. The second component reflects variation in the higher slope values – those between 75° and 85°. However, the third and final component is different. This is comprised of variation in the 20°-25° and 85°-90° increments. This may be due to the amalgamation of the data to represent the whole tools, resulting in variation in the higher increments being increased and thus being represented in the first and second component.

Figure 6.6. Principal component analysis of slope data for individual handaxe surfaces. Surfaces are labelled "T" for top and "B" for bottom. Again, the top graph displays the cluster analysis results, using six unique clusters. The bottom graph displays the actual values of knappers involved in the experiment.

Figure 6.7. Principal component analysis of slope data for whole tools. The individual handaxe numbers are displayed. The top graph displays the cluster analysis results, using six unique clusters. The bottom graph displays the actual values of knappers involved in the experiment.

Again, the principal components data was plotted using scatter diagrams. Cluster analysis was also applied to the data and the results were used in an attempt to isolate groups within the principal components data that may reflect the individual knappers. A comparison was made between the suggested clusters provided by the statistical test and the known values of knappers (Figures 6.6 and 6.7). Again, the cluster analysis was unable to accurately link the tools to their creators. The slope analysis appears to be displaying factors that are not connected to the knappers individual mark. Also, the analyses of the top and bottom surfaces of the handaxes do not cluster in pairs, as one would expect. This is akin to the analysis of aspect, and is again taken to suggest that knappers often approached each face of the tool in a different way. However, when the identities of the knappers were revealed and mapped onto the data, the analysis of the presented one interesting result. As shown in Figure 6.6, five of the handaxes produced by Knapper 1 cluster together. Although the handaxes made by the other knappers show no obvious groups, this suggests that an individual knapper may attempt to strive towards producing tools of a similar thickness. It should also be noted that of the outliers in Knapper 1's group two are pointed, while the five that do group together are all ovate in shape. This indicates that shape is likely to be the primary influence over the slope given to the handaxe by the knappers thinning technique.

Discussion

Figure 6.8. Principal component data from the analysis of aspect, grouped according to Roe's (1968) method for analysing handaxe shape.

The results of the experiment have shown that a three-dimensional analysis of handaxe morphology appears to fail in tracing individual idiosyncrasies that allow tools to be linked to their creators. Instead, the data produced is highly indicative of shape, suggesting that the topography of a tool's surface is constrained by the overall shape that is applied to it. To test this hypothesis, each of the handaxes was subjected to Roe's (1968) methodology for defining shape, and the results were mapped onto the principal components results (Figure 6.8 and 6.9). As the figures show, there is a clear definition between ovates and points. This supports the notion that the shape of the handaxe has a major role in dictating much of its morphology. To what extent the knappers influence could change the final shape of the tool remains unknown. However, as shown in Figure 6 and discussed above, the cluster of ovates made by Knapper 1 demonstrates that knappers may have had an ideal goal in mind when carrying out the final shaping of the biface. Nevertheless, individuals who choose to make their tools conform to an ideal standard are apparently concealed by broad scale variation in the habits of other knappers.

Figure 6.9. Principal component data from the analysis of slope, grouped according to Roe's (1968) method for analysing handaxe shape.

Although this experiment at first appears to be a failure, it must be remembered that it set out to test a hypothesis. This was that the idiosyncratic traits of individual knappers could be traced through the three-dimensional morphology of stone tools. The results of the experiment have shown quite clearly that it is shape that influences the three-dimensional characteristics of tools, rather than the knappers themselves. Of course, it could be said that the knapper has a specific goal in mind to produce the desired shape, or that shape is governed by other factors, such as raw material (for example White 1995, 1998). However, the extent to which either of these hypotheses is true remains to be seen.

In addition, the findings of this paper have important implications for the applications of social theory to Palaeolithic archaeological contexts. As discussed in the opening of this chapter, there are deep-rooted problems in attempting to interpret a material record as sparse and spread over as great a period as the Palaeolithic is. It was suggested that to truly understand artefacts in terms of a 'bottom-up' approach, then the individual hominin must become the focus of our studies. Also, for such studies to move beyond the "naïve reconstructionism" that is suggested to be prevalent in current theoretical approaches (Hopkinson & White 2005), we must be able to trace the actions of individuals within the material record. The conclusions of the analysis of three-dimensional characteristics of stone tools has shown that these elements are constrained by the shape of the tool and do not point to the knappers that created them. From this, it appears that the knapper's own idiosyncrasies are hidden from the archaeologist's view, which makes tracing their imprint across the material record nigh on impossible.

Despite the fact that the observations presented here demonstrate the improbability of detecting the signature of a tools creator, it should be remembered that this is a single method within a suite of experiments. While this mode of analysis has been unable to accurately attribute tools to the knappers who made them, future studies that approach lithic artefacts from other directions may provide a more precise strategy for the analysis of the individual. Already, the refitting of flake debitage produced from stone tool manufacture has provided some headway towards this goal (Foulds 2010). Whether we can disentangle the individual from the material, and thus provide a more accurate representation of the social facets of Palaeolithic life, remains to be seen through the course of future research.

Conclusions

This paper has provided a critique of the current approaches to the interpretation of Palaeolithic material culture from the social perspective. The suggestion has been made that these studies result in theoretical discourse that provides 'a way of thinking', as opposed to 'a way of doing'. Therefore, these interpretations become *akin* to stories told about the past, rather than an accurate depiction of the lives of the hominins we attempt to study. To move beyond this, we must attempt to move our analytical focus deeper, in order to see the social relationships that bound such hominins together. One way of achieving this that has been put forward is to study the individuals that construct and maintain these relationships. Whether this is possible, however, will have striking implications for our understanding of deep prehistory.

The experiment presented here has explored one approach to the analysis of the individual. The results of this analysis have shown that the overall shape of tools has a strong bearing on the three-dimensional characteristics that were studied. Thus the individual becomes hidden behind a façade created by the tools morphology. It is hoped that future research, which considers the individual element in the construction of artefacts, will be able to tease this from the material it is contained within and open up new avenues for the social interpretations of Palaeolithic archaeology.

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Total Variance Explained						
Component	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2.624	32.798	32.798	2.624	32.798	32.798
2	1.543	19.284	52.082	1.543	19.284	52.082
3	1.316	16.445	68.527	1.316	16.445	68.527
4	0.917	11.462	79.989			
5	0.778	9.73	89.719			
6	0.504	6.3	96.019			
7	0.318	3.98	100			
8	3.89E-05	0	100			

Component Matrix			
	Component		
	1	*2*	*3*
North		0.578	0.544
North East		0.834	
East			
South East	0.575		
South	0.795		
South West	0.585		
West			
North West			

Total Variance Explained

Component	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2.964	37.056	37.056	2.964	37.056	37.056
2	1.507	18.839	55.895	1.507	18.839	55.895
3	1.374	17.171	73.066	1.374	17.171	73.066
4	0.829	10.362	83.428			
5	0.652	8.148	91.576			
6	0.45	5.627	97.203			
7	0.224	2.797	99.999			
8	4.89E-05	0.001	100			

Component Matrix

	Component		
	1	*2*	*3*
North		0.706	
North East			0.588
East			
South East	0.741		
South	0.831		
South West	0.657		
West			
North West		0.557	

Total Variance Explained

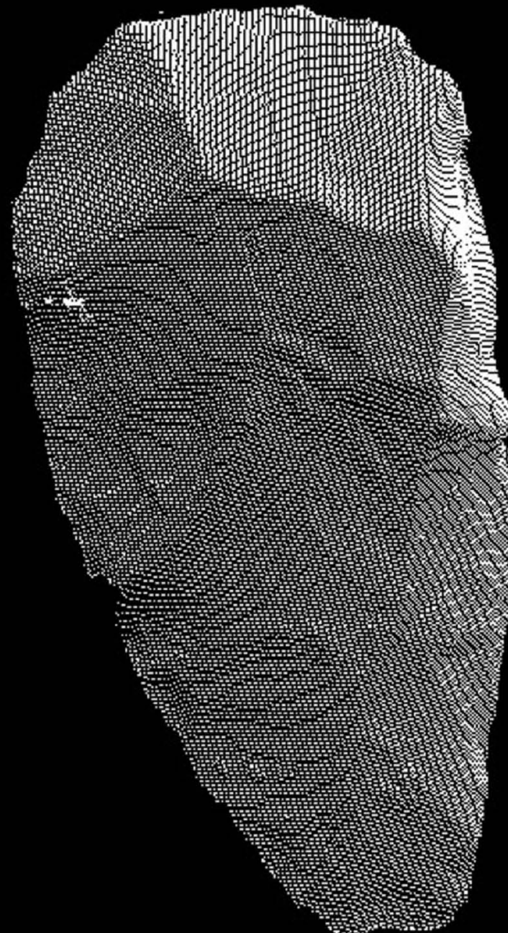
Component	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	10.227	56.814	56.814	10.227	56.814	56.814
2	3.017	16.762	73.576	3.017	16.762	73.576
3	1.806	10.034	83.61	1.806	10.034	83.61
4	1.046	5.812	89.422	1.046	5.812	89.422
5	0.582	3.231	92.653			
6	0.425	2.362	95.015			
7	0.344	1.912	96.927			
8	0.204	1.133	98.06			
9	0.11	0.612	98.672			
10	0.095	0.529	99.201			
11	0.044	0.245	99.446			
12	0.033	0.184	99.63			
13	0.023	0.127	99.757			
14	0.022	0.125	99.882			
15	0.01	0.054	99.936			
16	0.007	0.038	99.973			
17	0.005	0.027	100			
18	3.14E-05	0	100			

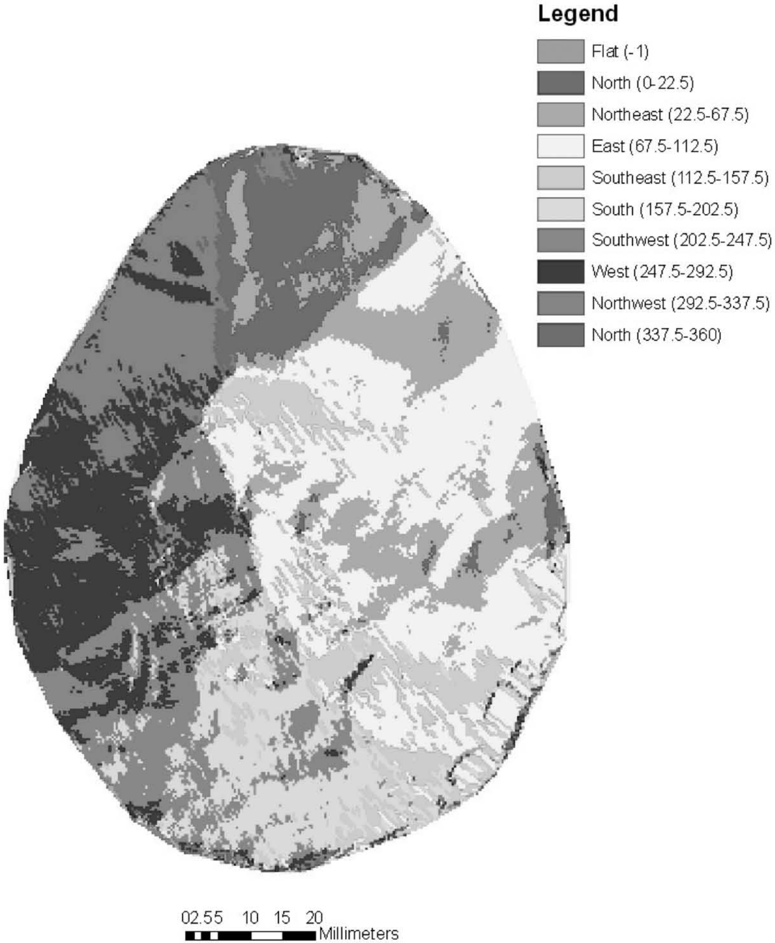
Component Matrix

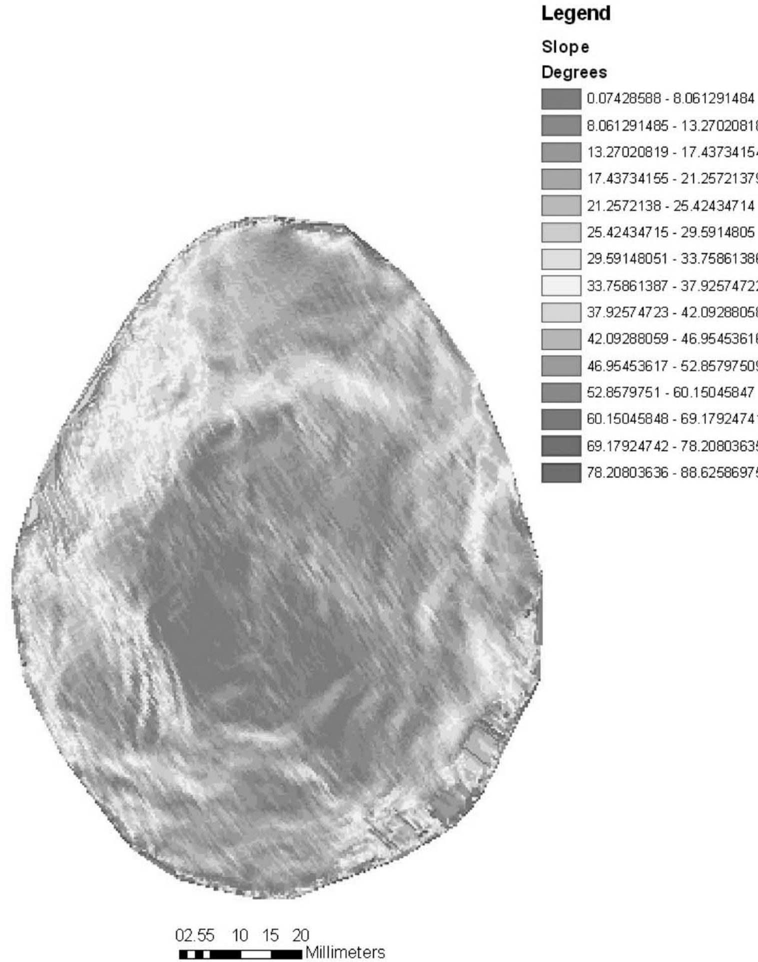
	Component			
	1	*2*	*3*	*4*
0-5				
5-10				
10-15				
15-20			0.55	
20-25			0.772	
25-30	0.558			
30-35	0.757			
35-40	0.874			
40-45	0.886			
45-50	0.915			
50-55	0.941			
55-60	0.88			
60-65	0.837			
65-70	0.754			
70-75	0.705	0.549		
75-80	0.527	0.55		
80-85	0.651	0.564		
85-90				0.663

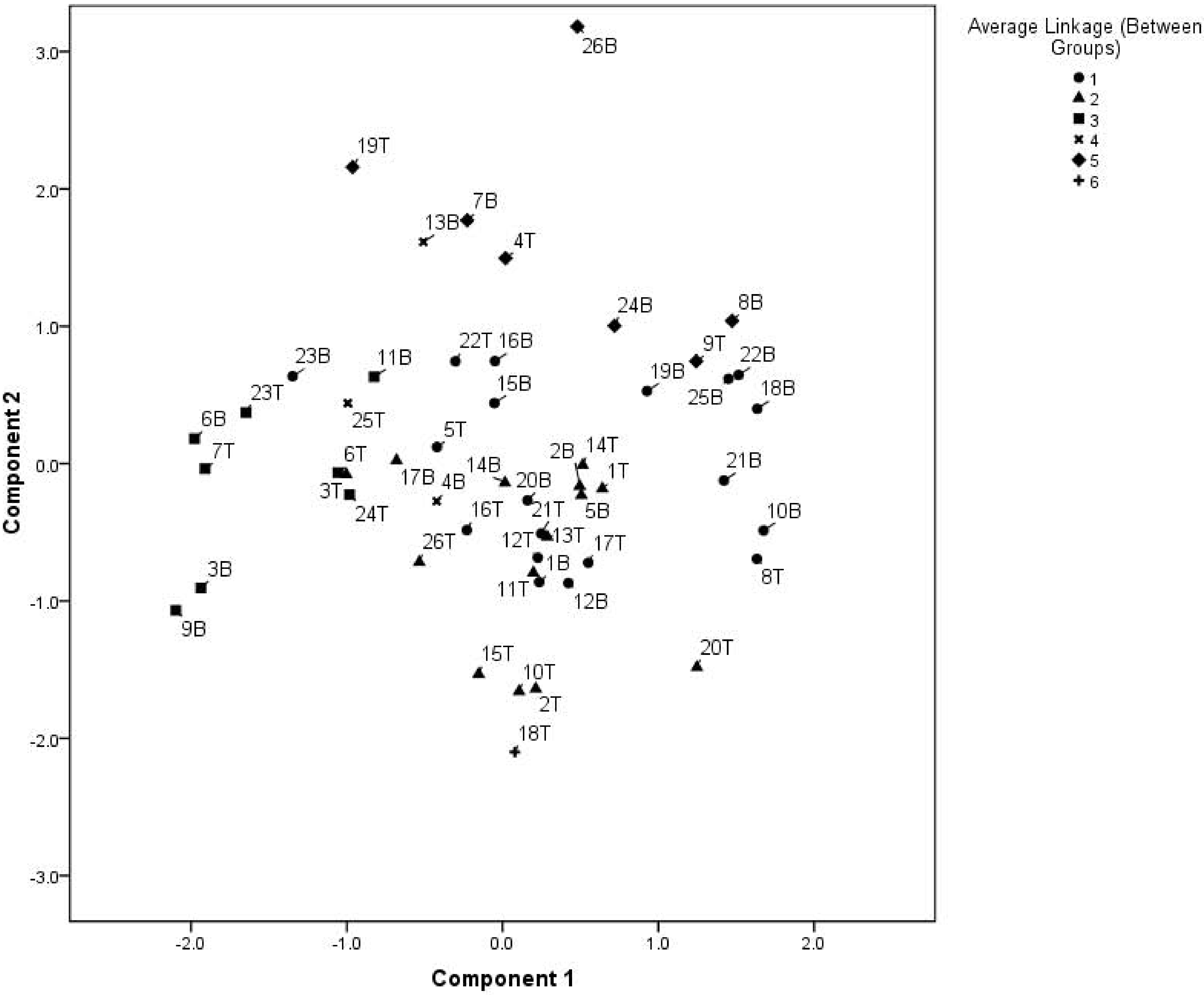
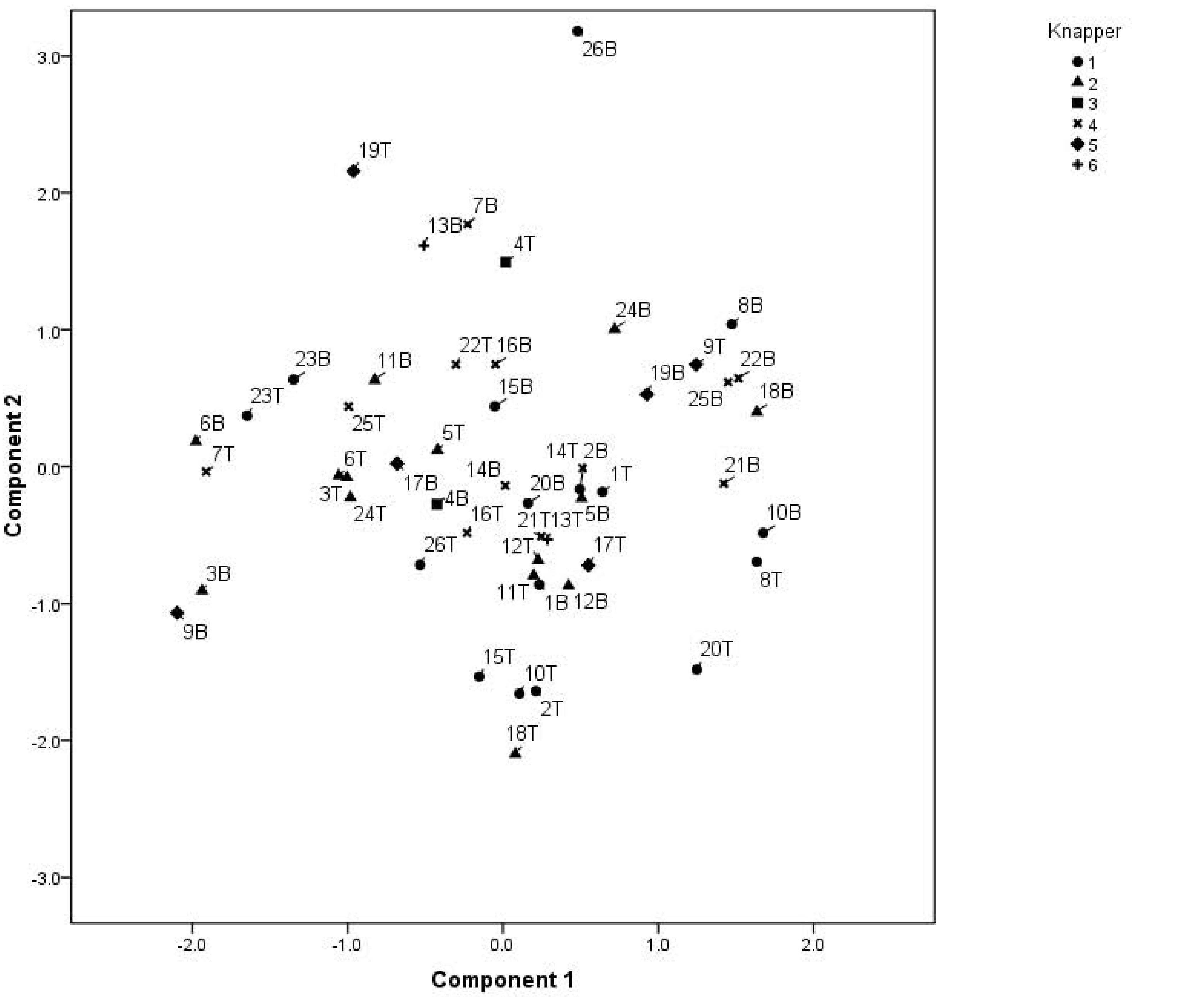
Total Variance Explained						
Component	***Initial Eigenvalues***			***Extraction Sums of Squared Loadings***		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	11.017	61.207	61.207	11.017	61.207	61.207
2	2.798	15.546	76.753	2.798	15.546	76.753
3	1.614	8.969	85.722	1.614	8.969	85.722
4	0.889	4.938	90.66			
5	0.671	3.73	94.39			
6	0.326	1.812	96.202			
7	0.259	1.441	97.643			
8	0.175	0.97	98.613			
9	0.106	0.588	99.201			
10	0.066	0.365	99.566			
11	0.03	0.166	99.732			
12	0.019	0.108	99.84			
13	0.013	0.07	99.91			
14	0.006	0.032	99.942			
15	0.005	0.03	99.972			
16	0.003	0.018	99.99			
17	0.002	0.01	100			
18	1.52E-05	8.45E-05	100			

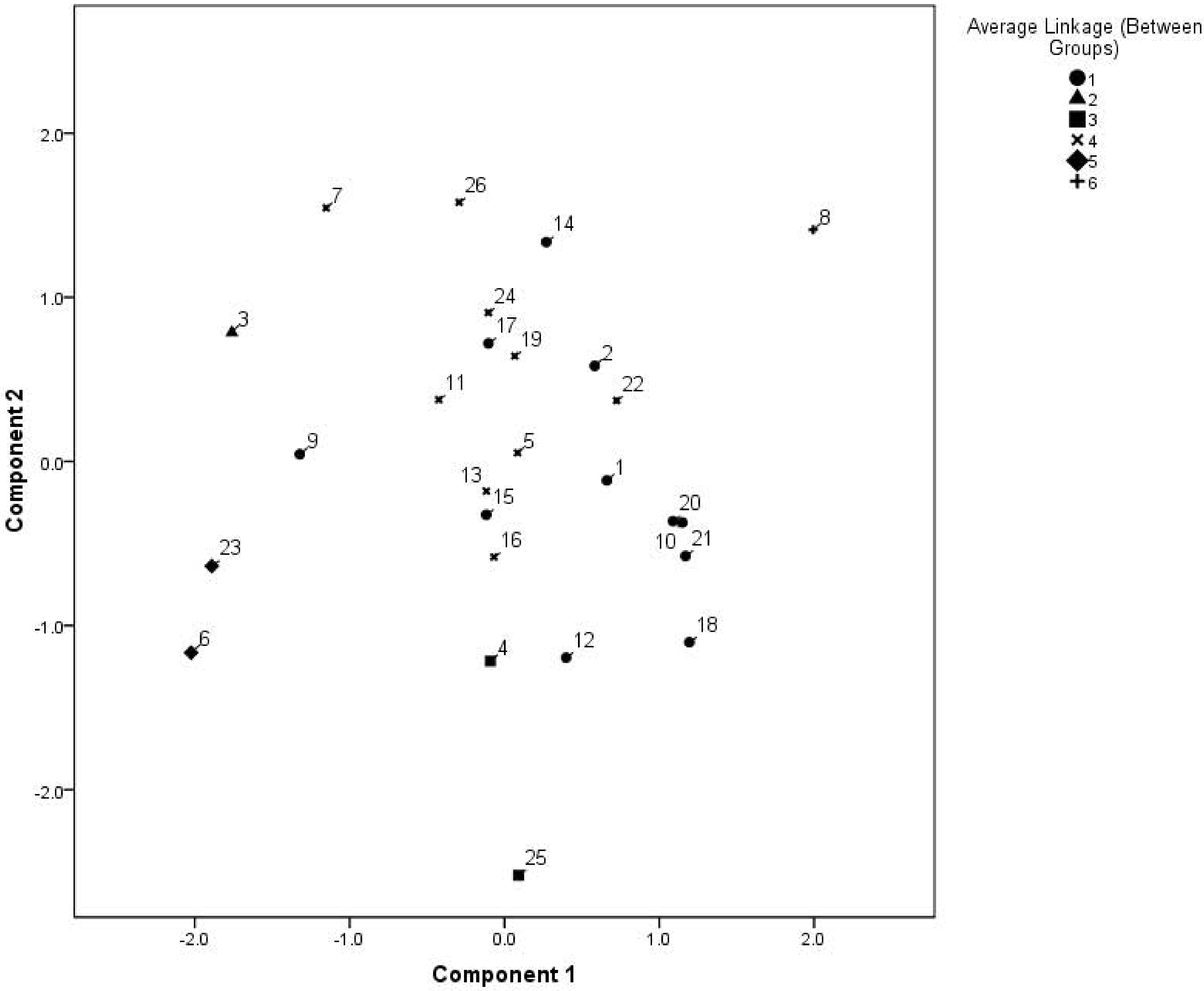
Component Matrix			
	Component		
	1	*2*	*3*
0-5			
5-10			
10-15			
15-20			
20-25			0.61
25-30	0.556		
30-35	0.815		
35-40	0.902		
40-45	0.913		
45-50	0.935		
50-55	0.969		
55-60	0.906		
60-65	0.863		
65-70	0.823		
70-75	0.769		
75-80		0.64	
80-85	0.63	0.591	
85-90			0.564

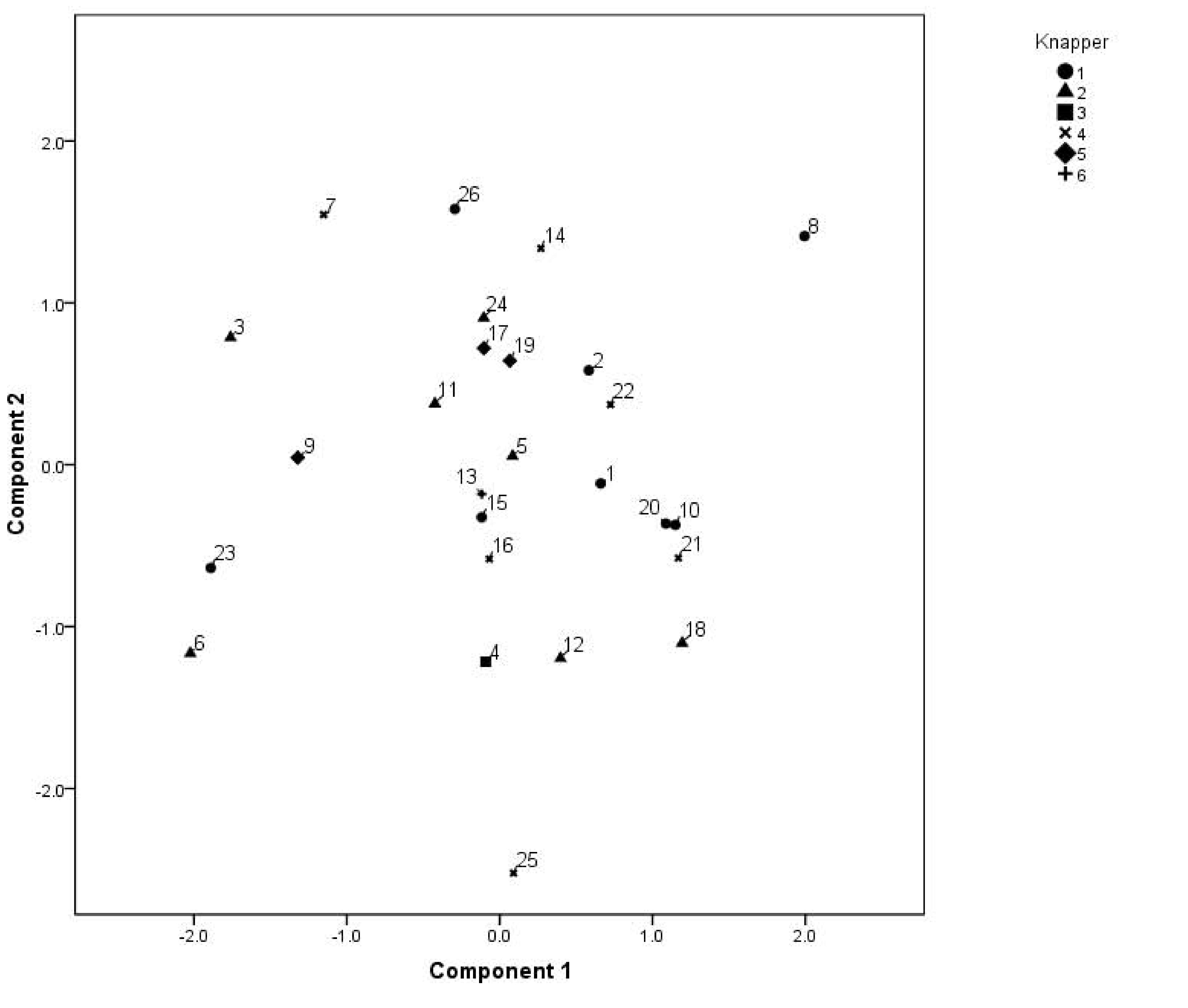



Legend
Flat (-1)
North (0-22.5)
Northeast (22.5-67.5)
East (67.5-112.5)
Southeast (112.5-157.5)
South (157.5-202.5)
Southwest (202.5-247.5)
West (247.5-292.5)
Northwest (292.5-337.5)
North (337.5-360)
02.55 10 15 20
Millimeters

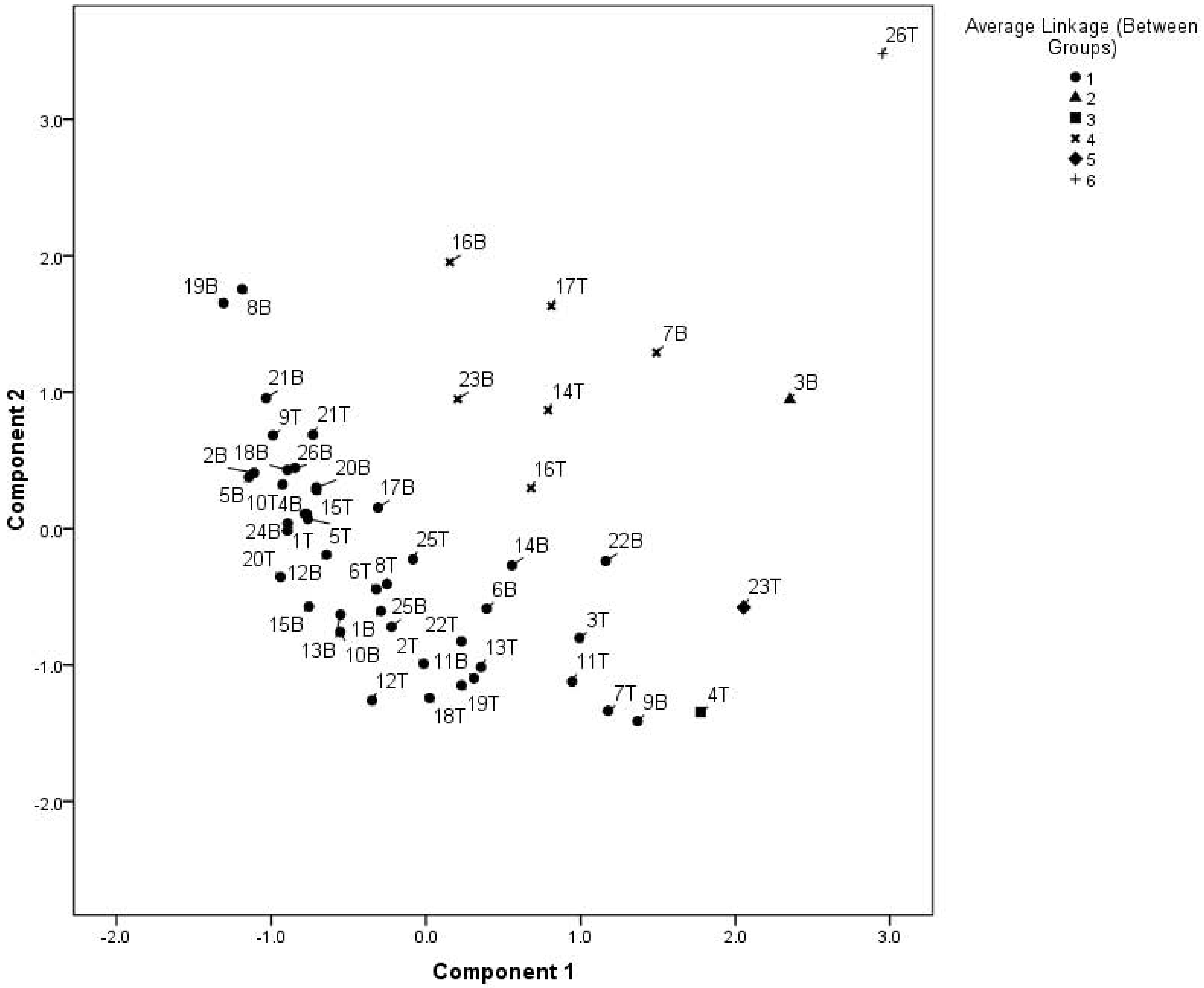

Legend
Slope
Degrees
0.07428588 - 8.061291484
8.061291485 - 13.27020818
13.27020819 - 17.43734154
17.43734155 - 21.25721379
21.2572138 - 25.42434714
25.42434715 - 29.5914805
29.59148051 - 33.75861386
33.75861387 - 37.92574722
37.92574723 - 42.09288058
42.09288059 - 46.95453616
46.95453617 - 52.85797509
52.8579751 - 60.15045847
60.15045848 - 69.17924741
69.17924742 - 78.20803635
78.20803636 - 88.62586975
02.55 10 15 20
Millimeters

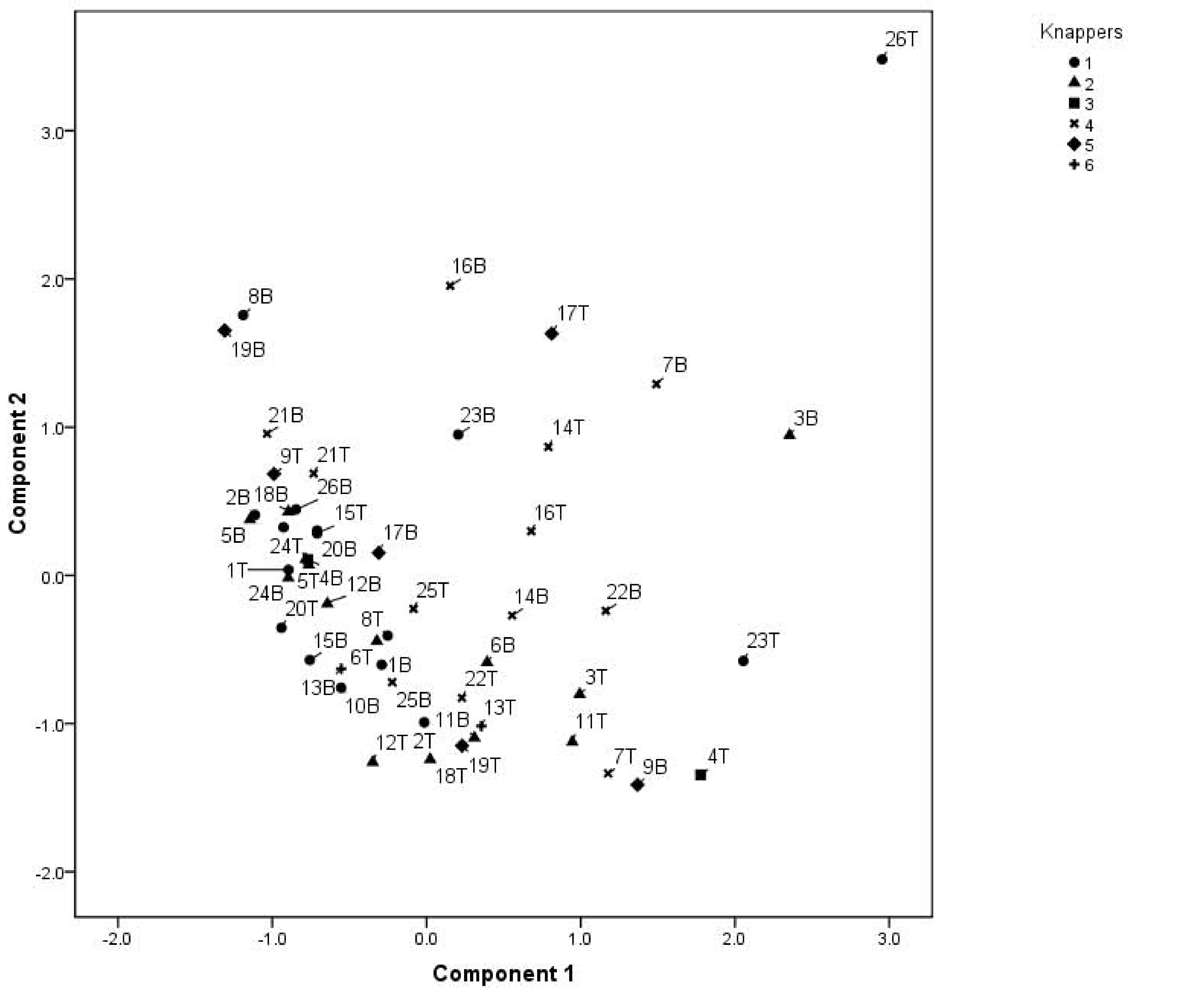

Average Linkage (Between Groups)
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
26B
19T
7B
13B
4T
24B
8B
9T
22B
25B
19B
18B
23B
11B
22T
16B
15B
23T
25T
6B
5T
7T
6T
3T
24T
17B
4B
14B
20B
2B
14T
1T
5B
21B
16T
21T
12T
13T
17T
10B
8T
26T
1B
11T
12B
3B
9B
15T
10T
2T
20T
18T

Knapper
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
26B
19T
7B
13B
4T
24B
8B
9T
22B
25B
19B
18B
23B
11B
22T
16B
15B
23T
25T
6B
5T
7T
6T
3T
24T
17B
4B
14B
20B
14T
2B
1T
5B
21B
16T
21T
13T
12T
17T
10B
8T
26T
11T
1B
12B
3B
9B
15T
10T
2T
20T
18T

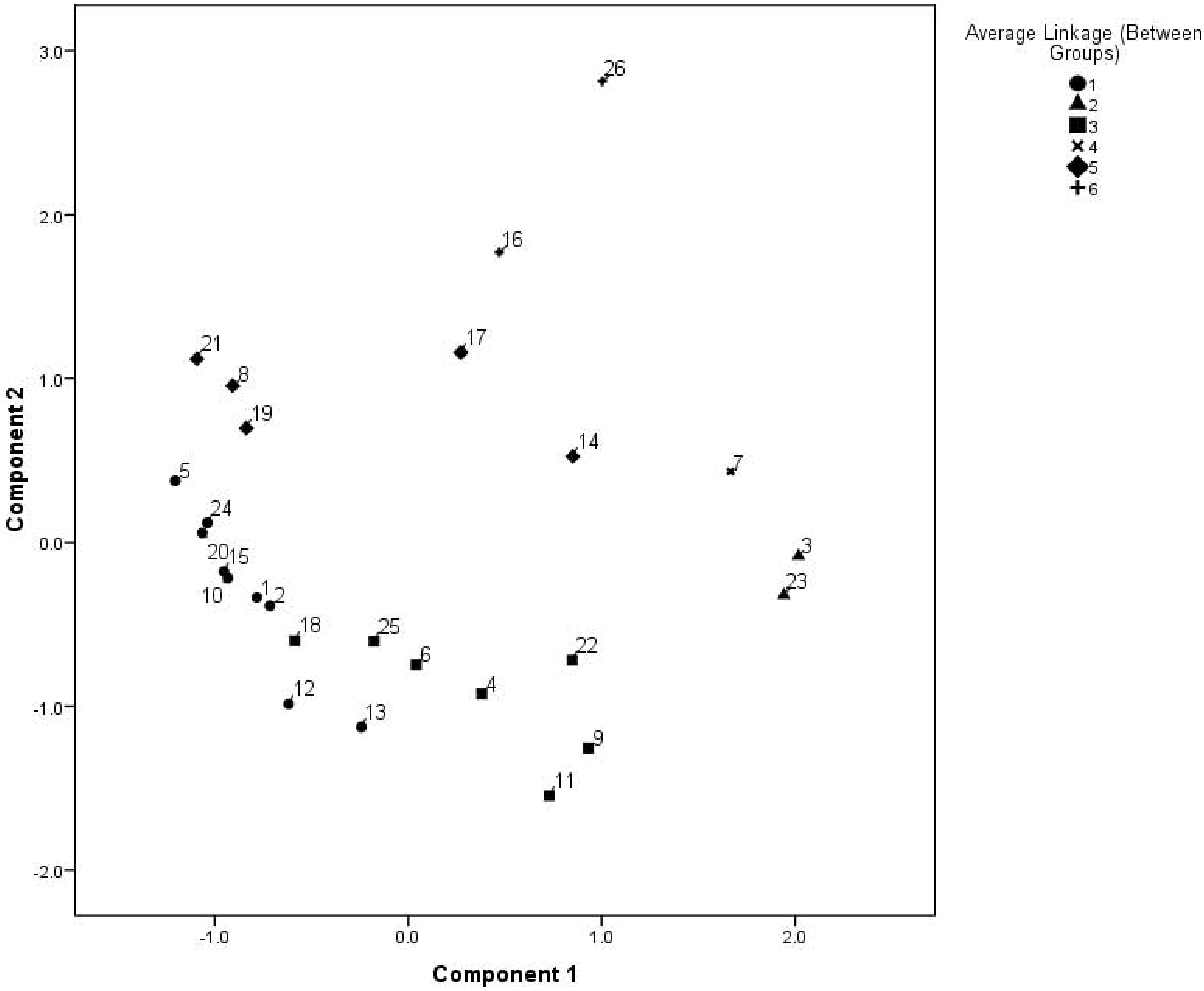

Average Linkage (Between Groups)
1
2
3
4
5
6
Component 2
Component 1
2.0
1.0
0.0
-1.0
-2.0
7
26
14
8
24
3
17
19
2
11
22
9
5
13
1
15
20
16
10
21
23
18
6
4
12
25

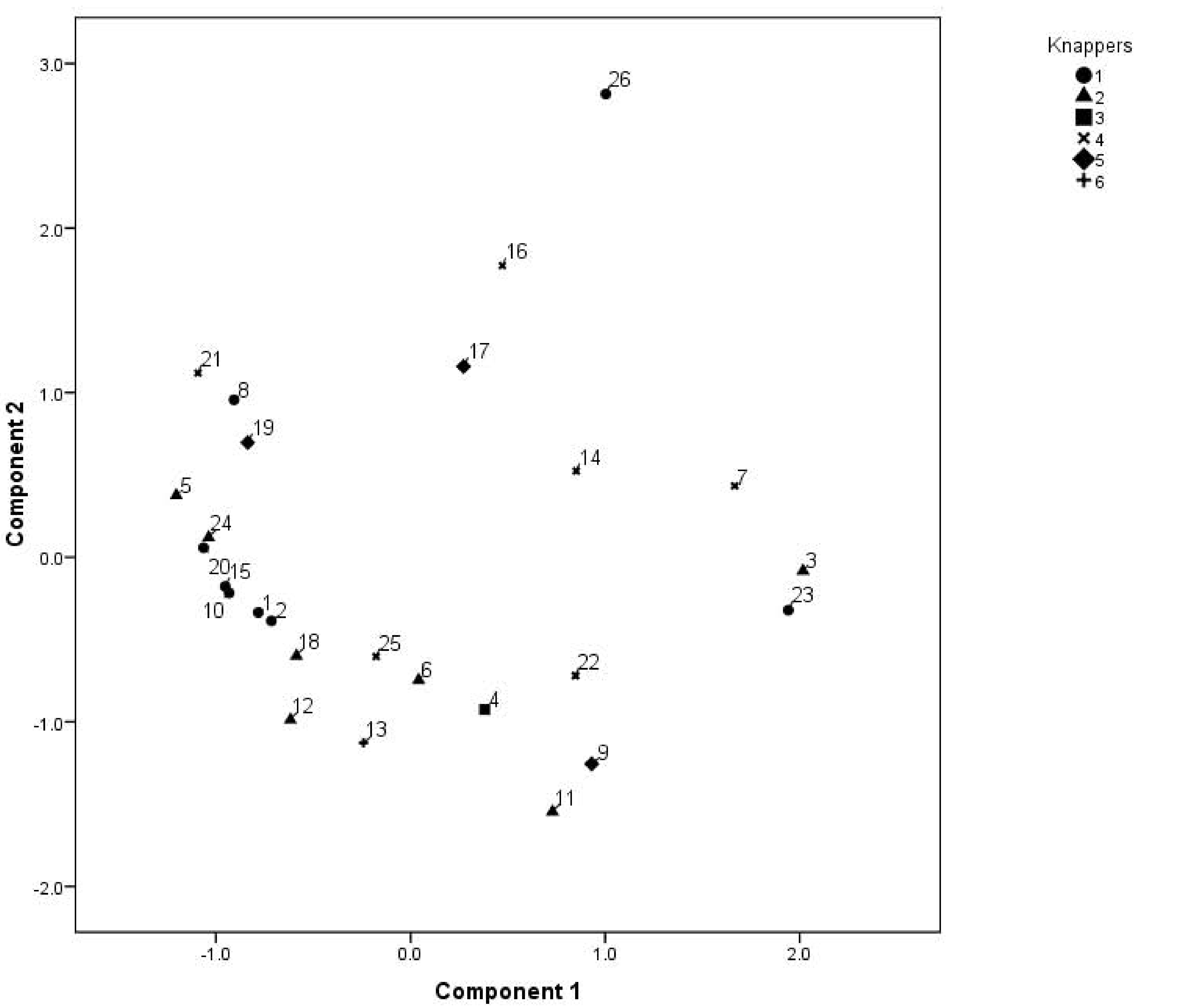

Knapper
1
2
3
4
5
6
Component 2
Component 1
2.0
1.0
0.0
-1.0
-2.0
7
26
14
8
24
3
17
19
2
11
22
9
5
13
1
15
20
10
16
21
23
18
6
4
12
25

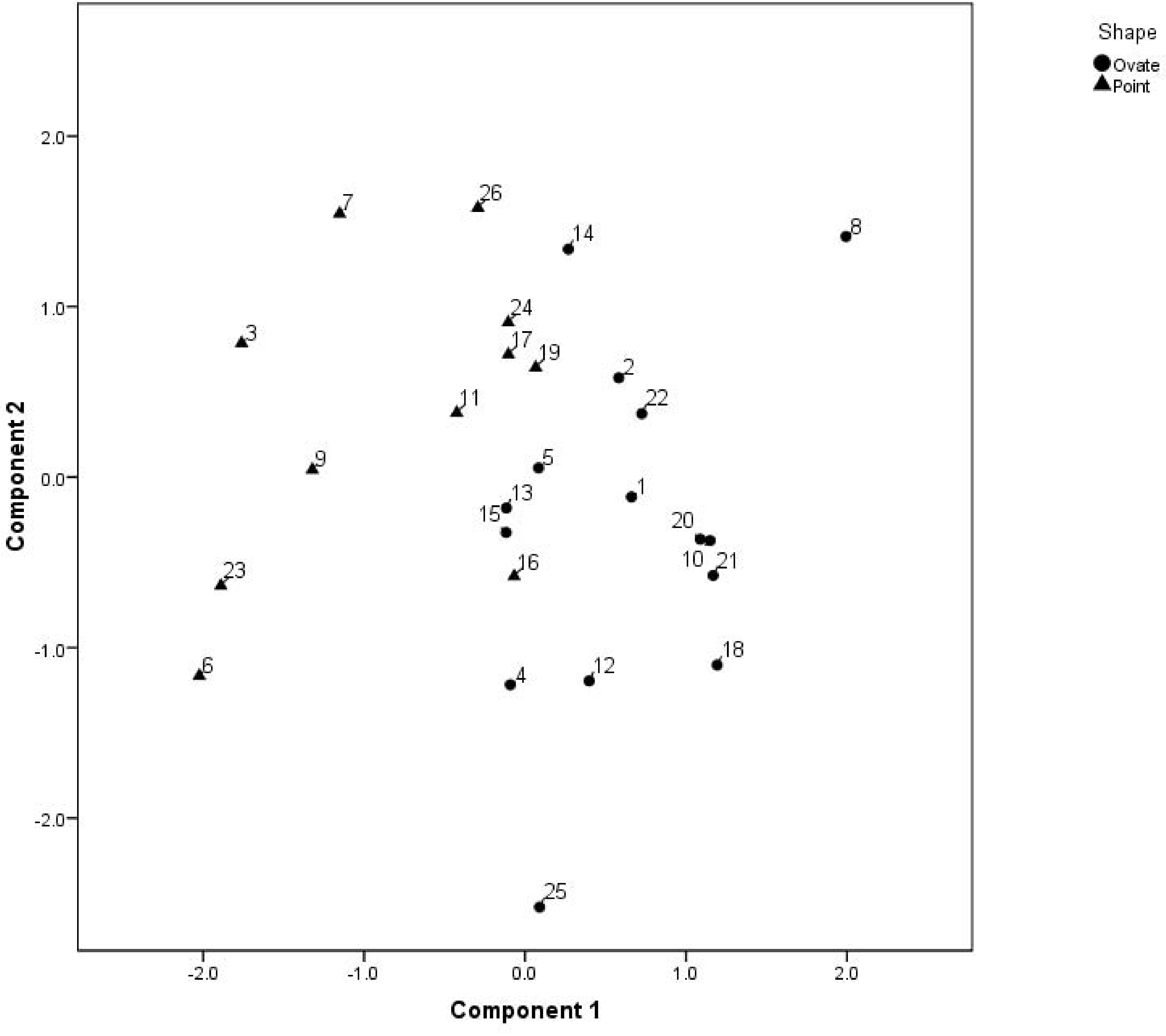

0 1 2 3 4 5 CM

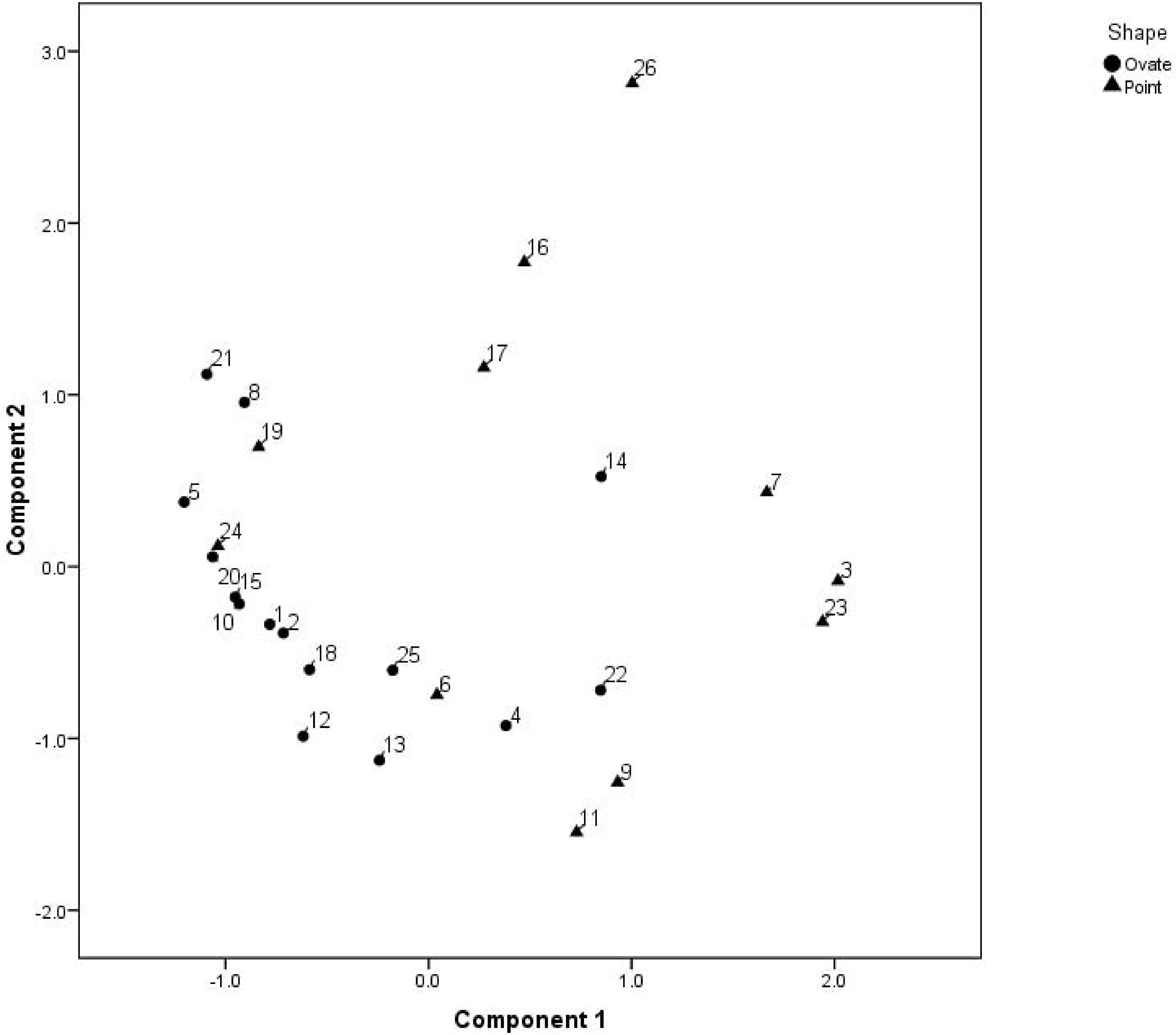

Average Linkage (Between Groups)
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
3.0


Knappers
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
3.0


Average Linkage (Between Groups)
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-1.0
0.0
1.0
2.0
26
16
17
21
8
19
14
7
5
24
3
20
15
23
10
1
2
18
25
6
22
12
4
13
9
11


Knappers
1
2
3
4
5
6
Component 2
Component 1
3.0
2.0
1.0
0.0
-1.0
-2.0
-1.0
0.0
1.0
2.0
26
16
17
21
8
19
14
7
5
24
3
20
15
23
10
1
2
18
25
6
22
12
4
13
9
11


Shape
Ovate
Point
Component 1
Component 2
2.0
1.0
0.0
-1.0
-2.0
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



Shape
Ovate
Point
Component 1
Component 2
3.0
2.0
1.0
0.0
-1.0
-2.0
-1.0
0.0
1.0
2.0
26
16
17
21
8
19
14
7
5
24
3
20
15
23
10
1
2
18
25
6
22
4
12
13
9
11