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INDIVIDUAL VARIATIONS AND THE RECONSTRUCTION OF PREHISTORIC PATTERNS OF ARTIFACT PRODUCTION: A TEST FROM THE LATE NEOLITHIC SITE OF DIVOSTIN, JUGOSLAVIA

by

STEPHEN A. KAUFMAN

A dissertation submitted to the Graduate Faculty in Anthropology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1977

This manuscript has been read and accepted for the Graduate Faculty in Anthropology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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CHAPTER I

INTRODUCTION

Definition of Problem

The research described below represents an attempt to resolve the controversy concerning the presence of ceramic specialization during the Balkan Neolithic and Chalcolithic (5500-3000 B.C.). This question has not been resolved because in part the data found in the literature or provided by excavations are inadequate. Moreover, past efforts employed to answer this question have been unsuccessful either because the theoretical expectations were inappropriate to the cultural system under consideration or the results of data acquisition were inconclusive or both. A new method based upon the recognition of idiosyncratic patterns in material culture provides a better means of examining this issue. The ceramic material from the house floors of the Late Neolithic site of Divostin in Jugoslavia is analyzed for idiosyncratic variation in vessel shape. The recognition of such patterns within the archaeological record permits inferences to be drawn about the number of potters within the village and ultimately about the organization of ceramic production.

Ceramic Specialization During the Neolithic and Chalcolithic

> There is in fact no evidence in Eastern Europe at this time in the form of a concentration of kilns or pots, to indicate that any settlement employed a specialist potter. (Tringham 1971:204)

> Craft specialization was developing in the craft of pottery manufacture. (Evans 1973:138)

All cultures, regardless of their economic base or level of social complexity, manifest an internal division of labor to some degree. This differentiation of function varies in degree as to the social categories involved and to the types of activities. On the simplest level, egalitarian societies have division of labor following age and sex distinctions. Division of labor becomes more intensified as the level of social complexity increases: in state level societies, we can speak of full time craft specialization and occupational specialization.

The degree of internal differentiation within a society is a customary index of cultural evolution. Using a comparative approach, several authors, e.g. Service (1962) and Fried (1967) have correlated the intensity of specialization with socio-political development. Accordingly, specialization beyond simple age and sex divisions is rarely encountered in band or egalitarian societies. Part time specialization is present in tribal or ranked cultures and full time specialists are found in chiefdom/stratified and state level societies. Specialization may not only be a measure of cultural evolution but perhaps a causal agent. Some recent models for culture change (Childe 1963, Hole and Heizer 1973: , Jacobs 1969, Rathje 1972, and Renfrew 1972) place an important value (with varying emphasis) on the development of specialization as a means of cultural transformation.

Naroll (1956) and Tatje and Naroll (1973) in two cross cultural studies have used the number of occupational specialities as one measure to assess the social complexity of a culture. Carneiro (1968) has treated specialization in a somewhat different manner to achieve his ranking of societies. Carneiro suggested that different occupational specialties, such as full time priests or scientists, emerge at different points along his Guttman scale of social complexity. Thus, the presence of a particular specialist can be seen as an indicator of a certain level of socio-political development.

From an archaeological standpoint, the problem becomes one of measuring specialization, as a prerequisite to using specializaion to evaluate cultural complexity. In this regard, it is necessary to limit the investigations of specialization to activities which produce archaeologically recoverable products. Indeed, Naroll (1956:695) restricted his cross cultural study to specialization involving durable goods "in the hope that archeologists may find the indicator usefull." While he realized that there were three types of specialization (service, producer of non-durable goods, and producer of durable goods), he focused upon the manufacture of durable goods with the expectation that there would be a corresponding number of specialists in the other catagories.

Thus, in the realization of the limitations of archaeological information retrieval, the analysis presented here will focus upon the question of specialization in ceramics, the most abundant artifact category represented at Divostin. While ceramic specialization is not a complete measure of craft specialization during the Late Neolithic at Divostin, it will help build such a measure.

The investigation of craft specialization in the Balkans is difficult for a number of important reasons. The first of these problems relates to the tradition of archaeology in this region. Archaeology, here, has generally been organized along the paradigms established for museology, art history and culture history, a fact emphasized in several recent publications (Evans 1973, McPherron 1973, and Sterud and Ivey 1972). These paradigms have not been concerned with the implications of craft specialization and thus the data are often not suitable to answer this question.

Craft specialization in the Balkans has generally been attributed to metallurgy alone (Childe 1957 and Tringham 1971:204). Childe for example spoke of smiths who were divorced from any commercial ties; e.g. itinerant smiths. The arguments used by Childe for considering prehistoric metallurgy to be a specialized craft industry are in large measure based on enographic analogies. This approach has been carefully examined by Rowlands (1971) and he concluded that the ethnographic evidence does not completely support the ideas of Childe on this matter. His examination of the ethnographic record demonstrated, however, a broad range of occupational specialization for this craft.

Evans (1971 and 1973) after reviewing the literature and available museum collections concluded that pottery and flint working should be added to the list of specialized craft industries for this time period. Evans's position on pottery specialization is by no means shared by the other students of Balkan prehistory. The published literature (Childe 1957, Clark 1965, and Tringham 1971) and Evans's interviews with resident archaeologists in Bulgaria and Rumania demonstrate this uncertainty (Evans 1973). Other factors which make the resolution of this question more difficult are the inappropriateness and inconclusiveness of some of the test implications derived from the examination of ceramic specialization as discussed below.

Measures Used for Delineating the Organization of Ceramic Production

The measures which have been used to infer the organization of ceramic production within a prehistoric site or culture generally concern two kinds of evidence: A) artifacts associated with ceramic manufacture and B) the ceramic vessels and their attributes. Some of the specific measures within each category are listed below.

A) Artifacts associated with ceramic manufacture

1. Tool kits used for the procurement of raw materials.
2. Exotic raw materials used in ceramic production.
3. Tool kits used fro the production of the vessels.
4. Kilns used in the firing of the ceramics
5. Storage areas for the placement of vessels for future sale or exchange
6. Workshops where potters manufacture the vessels

B) Ceramic vessels and their attributes

1. Marks placed on the vessels which indicate the producer
2. A high degree of technological complexity involved in the production of the artifact which precludes all people from posessing the necessary skills or knowledge
3. A very narrow range of variability in artifacts which indicates that the items were manufactured by a particular individual

The use of these measures by archaeologists has hardly been adequate for resolving the issue of the organization of ceramic production within the Balkans. In part this stems from faulty ethnographic comparisons or archaeology data base. For example, Evans (1971 and 1973) has used tool kits for the procurement of raw materials (antler picks for obtaining clay) and the manufacture of the vessels (pebble polishers, scrapers, bone knives, etc.) as indices of ceramic specialization. This measure seems suspect because tool kits related to ceramic production and procurement of raw materials are used by the specialist and non-specialist alike (David and Hennig 1972, Ferguson 1975, and Shepard 1968:54-72). These tools are indispensable to all potters engaged in regular ceramic production. Their presence in an archaeological site cannot be used to infer specialization as Evans has indicated. Nor can their absence be used to infer household production. Tools are often curated and hence of low archaeological visibility (Binford 1973 and Guthe 1925). They are also frequently made of organic materials (wooden paddles, bone, wood, or shell scrapers, antler picks, and bone or wood decorative tools) which are subject to decay. Therefore it is less likely that a representative sample of these items will be recovered archaeologically. Tool kits may be used with some reservation to infer organization of production when they are evaluated within the broad context of a site. Are tool kits found within only one structure or are they associated with many similar structures? The former is a more convincing argument for specialization, but cannot stand alone without other supporting evidence. Unfortunately excavations in the Balkans as elsewhere have not been governed by any explicit sampling strategy and when entire sites or levels have been excavated, the relevant data for these questions have not been presented. This makes contextual interpretations problematic.

Kilns have also been used to measure the organization of ceramic production. Tringham (1971:204) has argued that the absence of "concentrations of kilns" would seem to preclude specialist potters. There are, however, a number of problems with the use of kilns as an index of ceramic specialization. The problems begin with the word kiln itself. Following general use of the word, kiln is defined as a structure where "the fundamental principle of the separation between the fire chamber and the pottery chamber is respected" (Balfet 1965:166). These as Balfet and Shepard (1968:75) have noted are generally associated with wheel made pottery. Since the pottery during the Neolithic and Chalcolithic of the Balkans is hand made, kilns as defined above, are not expected. To my knowledge true kilns have not been reported at any site dating to this time period in the Balkans. If kilns were not used, then following general ethnographic analogy simple firing areas or pits were probably employed in the firing procedures (Shepard 1968:75-77).

The use of simple firing areas or pits raises several problems. I would expect that the firing area would not be recovered archaeologically with any regularity because they are simply too ephemeral. Numerous ethnographic accounts report the use of ephemeral firing areas in <u>specialized</u> ceramic producing communities. For example David and Hennig (1971:6) described the firing procedures of the specialist potters of the Fulani and Gisiga in the following manner:

> They [the vessels] are laid out on sticks and covered with brush or thatch, or matting, or in the case of the Gisiga, with sticks and cattle dung. The Gisiga fire burns steadily for three to four hours, after which the eating bowls and beer pots are pulled out and placed in or over smoldering ass dung.

According to Ellen and Glover (1974:358) the specialist potters in the village of Ouh on the island of Saparua in the Central Moluccas fire their pottery in the following manner:

> In order to fire the pottery a wooden frame is built on four small stones about one meter apart, on top of which bundles of wood are laid in a single direction . . . . Pots are arranged by placing them against a central upright faggot along with further bamboo and particularly old lenghts of thatch (<u>atap</u>) from the leaves of

> the sago palm, which are said to burn rapidly with considerable heat. The only firings observed were small, only four pots at a time and lasting about ten minutes.

The same type of firing area is also found in communities engaged in household production. DeBoer and Lathrap (1976) described the use of simple firing areas among the Shipibo-Conibo in Peru. How then do we discriminate between the firing areas of the specialist potters and those of the non-specialist? In the absence of a communal firing pit, one can at least theoretically argue that there might be a greater concentration of firing pits in a village engaged in household production (many potters) than a village with one or two specialist potters. So, concentrations of "kilns" seem potentially misleading as well. Therefore, given the ephemeral nature of the firing areas expected at sites from this time period and the similarity between specialist and non-specialist firing areas, the presence or absence of such features does not appear to be a very useful measure of the organization of ceramic production.

As one last example of the difficulties which are encountered in examining the issue of the organization of ceramic production, numbers of pots have been used to infer storage areas and hence, ceramic specialization. Evans (1973:84) has listed several sites with "more [vessels] than I would expect for the domestic use of a household." The pots within these houses sometimes numbered in excess of 100 vessels (Evans 1971:470). Aside from not establishing the number of vessels needed or used by a single household, Evans does not provide evidence on the numbers of vessels within each of the vessel categories found within the houses. Are all or most of the vessels from one or two vessel types or are they equally divided among many vessel categories? The former is a far more convincing argument for specialization.

Similar problems can be raised with almost every measure listed above. These problems arise as stated earlier from an imprecise knowledge of ceramic manufacture and the lack of sufficient data. These limitations, however, can be overcome when sufficient data are available and control over the relevant variables is exercised. For example, maker's marks have been used by both Richter (1946) on pre-Hellenic Greek materials and Donnan (1971) on Peruvian Moché ceramics to reconstruct the organization of ceramic manufacture.

Excavations conducted at Divostin, Jugoslavia have yielded sufficient data (rim sherds <u>in situ</u> on several house floors) to test for ceramic specialization using the notion of product uniformity. This idea is suggested by Evans (1973:85-86) in his dissertation. He stated:

> One of the most important aspects of the development of craft specialization is the increasing amount of time to which a specialist is able to devote to his craft . . . . At the same time there is a general tendency for the product uniformity. That is the products of a single craftsman or groups of craftsmen tend to become uniform in size, shape, decoration, etc. . . . .
>
> It is expected that groups of craft products from the East Balkan Chalcolithic, which can be assigned to a particular craftsman will show a rather high degree of uniformity. This may be measured through the dimensions of size, shape, finish or decoration.

Evans sees product uniformity as an outgrowth of craft specialization. While craft specialization may lead to such standardization, there is reason to believe (see below) that product uniformity can also be seen in non-specialized or household industries as well. That is, in both specialized and non-specialized industries alike, individual producers can be identified by the minor differences in their products. I intend to use the concept somewhat differently than Evans to assess the organization of ceramic production at the Late Neolithic level at Divostin.

Evans did not provide any empirical evidence or extended discussion to support this important idea. In fact, I have found it difficult to find a suitable body of anthropological literature or data which relate to this issue. Since the analysis of idiosyncratic variation or product uniformity represents the means through which I will test craft specialization, I feel that it is important to examine this issue more closely.

<u>Product Uniformity and Idiosyncratic Behavior</u>

> The idea that the artist is nameless, lost in an undifferentiated mass, is a conception to be traced back, in the first place, to our incapacity to distinguish as soon as we are faced with human types whose appearance seems very unlike our own. Man has always had this difficulty . . . . (Gerbrands 1967:14)

It has long been recognized within the humanities that idiosyncratic patterns are firmly established in the material objects produced by artisans in a variety of mediums, including painting, music and writing (see Paisley 1964 for a summary of techniques for and cases of author identification in the humanities). In a general way, the recognition of these patterns allows the interested layman to identify at a glance the work of Rembrandt, Calder, Miro or Monet. These artists all have easily identifiable patterns based upon the use of color, form, subject matter, etc.

These broad patterns of idiosyncratic behavior are only a first approximation when unsigned works are suddenly discovered which seemingly belong to one of the great masters. These broad patterns suggest a particular artist, but can the work be attributed to him, to a contemporary working in the same style, or perhaps to an artful forger? Newly discovered works by these masters are of great historical and financial importance and much effort is directed towards authenticating these questionable items.

Prior to the development of physio-chemical techniques which could separate the present day forger from the great master, careful analyses were made of such items as type of brushstroke and thickness of paint to reveal the true identity of the artist. This type of analysis is still necessary when discriminations are desired between great masters and contemporaries working in the same style. While such studies have in large measure been restricted to the humanities, these analyses strongly support the idea that individuals manifest particular and unique "fingerprints" on the material objects they produce, that is, repetitive idiosyncratic characteristics indicate that product uniformity can be used to identify individual artists.[1]

Idiosyncratic Patterns in More Traditional Craft Industries

If idiosyncratic patterns are clearly discernible in the works of great masters, are similar patterns to be noted in the material objects of craftsmen in the more traditional societies? Anthropologists in studying the artist in traditional communities have generally ignored the detailed examination of this question while assuming the presence of differences in detail which identify individual craftsman.

[1] David Thomas (1975) reported the presence of fingerprints on vessels of Harrapan origin which permitted the identification of individual potters.

In theory one can argue for such distinguishing characteristics. One such approach is based upon the normative view of culture, which places culture in the collective mind of the group. Thus, a cultural template can be said to exist for a particular type of object. Studies concerned with idiosyncratic patterns may form a subset of these normative analyses, though not all differences result from differing templates among artisans. The recognition of idiosyncratic patterns is an attempt to recover "the idea of the proper form of an object [that] exists in the mind of the maker" (Deetz 1967:45).[1]

The recognition of mental templates within archaeology has had a long tradition, perhaps formally beginning with Rouse's (1964) seminal publication, Prehistory of Haiti. Though not using the term mental template and standing apart from other archaeologists' typological thinking, Rouse was clearly referring to this in his description of modes. Rouse (1964:15) stated: "Modes are community wide standards which influence the behavior of the artisan as he makes the artifacts."

Hill and Evans (1972) provided an excellent summary and analysis in which they discussed the history of the type concept in American archaeology. They concluded (Hill and Evans 1972:242): "most types are assigned at least implicit meaning, and the most common assumed meaning is 'mental template'." In their summary, they discuss the long standing tradition of this concept, noting its widespread occurrence throughout what Willey and Sabloff (1974) for

---

[1]Though the normative view of culture has been criticized for certain limitations (Binford 1968), its usefulness can be seen by the material to be presented in the following chapters.

American archaeology call the Classificatory and Explanatory Periods to the present. Although each archaeologist has used the type concept somewhat differently, Hill and Evans identified a number of archaeologists, including Krieger, Spaulding, Smith, Deetz, Clarke and Hole and Heizer as having made recent and "notable statements that forcefully espouse the view" (Hill and Evans 1972:243) of typological analysis as the study of mental templates.

Formal studies of idiotemplates are recognized within the type variety method of classification. Hill and Evans (1972:242) in summarizing Gifford noted: "varieties were regarded as individual or small group deviations from the norm." Therefore, classification of ceramics following this outline where varieties have been identified have implicitly recognized the possibility of idiosyncratic patterning within the archaeological record. These analyses, however, have not been used for other than descriptive and historical purposes.

Differences in similar objects produced by two or more artisans over a short period of time can be attributed to conscious and unconscious factors. People who share a cultural template for one class of objects can still exercise some choice, albeit small, over the final form of the object. Therefore, some of the differences which are present in a set of essentially similar objects made by two different artisans are the result of slightly different conscious interpretations of the same cultural template which they share. These individual patterns may be referred to as idiotemplates. Other differences perhaps emerge between two producers who share the same mental template because there are differences in skill, motor patterns, etc. I will not, for the materials presented in the following chapters, attempt to designate the sources of the variation among artisans. I will only use the differences among artisans to infer the organization of ceramic production.

Therefore, differences are thought to emerge in sets of artifacts by different artisans because of both conscious factors including attempts to be different and different idiotemplates (cf. Bunzel 1929 and Gerbrands 1967) and unconscious factors including differences in motor patterns and skills (cf. Balfet 1965, Gerbrands 1967, and White and Thomas 1972).

Furthermore, there is some empirical evidence that supports the idea of individual distinctness (Gerbrands 1967, Gunn 1972, and White and Thomas 1972). The last of these studies will be examined in greater detail in the following chapter. These studies suggest that the differences which do emerge in a set of artifacts by one artisan will have a distinctive range of variation. That is, the range of variation for an artisan will be distinct when compared to another artisan despite the possibility of overlapping resulting from participation in the same "cultural template".

Idiosyncratic Patterns and Systems of Ceramic Production

If individual producers can be isolated within a community, it should then be possible to determine, by the number and distribution of producers within the community, whether or not craft specialization is present. That is, studies in idiosyncratic variation permit inferences to be drawn about systems of production.

Unfortunately, Evans was unable to test his ideas relating to product uniformity (Evans1973:86). He concluded:

> I have found that it would be extremely difficult (if not impossible) to obtain a sample from any particular site of the Balkan Chalcolithic with the necessary information of provenience and association to carry out this type of test.

I believe that Evans encountered this difficulty because he restricted his analysis to complete vessels. If product uniformity is found on complete vessels, then it should also be observable in the incomplete parts of vessels represented by rim sherds. I have found it possible to test for product uniformity using a sample of rim sherds from the Late Neolithic site of Divostin.

This series of rim sherds is used to identify individual producers within the community. These rim sherds are located in different houses within the village so that adequate controls of the relevant variables are established. Comparisons of households are made to see if the ceramics within the houses are distinct from one another. If distinctness is demonstrated among houses, then one likely inference is that production was located within each house. That is, the system of ceramic production in the village was not specialized. Provided that the hypothesis is true and distinctness is not demonstrated between houses, then it can be inferred that a potter's production was shared by a number of households. This would then be an indication of craft specialization (see chapter II for a more complete discussion of the control of relevant variables and alternative models of interpretation).

In order to evaluate the small differences in vessel shape caused by differing idiotemplates and motor patterns, a new measurement system based upon the use of polar coordinate data is used. This has two advantages over other types of ceramic analysis. First, it is possible to record data along the entire vessel profile at specified intervals. Second, the data are quantified, permitting mathematical expressions of vessel form. The polar coordinate technique's capacity for measuring small differences relatable to idiosyncratic variation is first tested by analyzing an assemblage of contemporary pots from Jugtown, North Carolina where the potters are known. These pots are produced by a community of potters who share a cultural template for the various vessel forms they manufacture. The demonstration of idiosyncratic distinctness within this experimental situation permits the use of this measurement technique on the Late Neolithic ceramics from Divostin.

CHAPTER II

AN ETHNOGRAPHIC CASE STUDY IN IDIOSYNCRATIC PATTERNING

The Aluni

Since the empirical evidence for idiosyncratic patterning and distinctiveness within traditional craft industries is scarce, I feel that it would be important to reexamine the evidence from one of the few available studies, namely that of White and Thomas (1972). Their data allow substantive evaluation of the degree of idiosyncratic variation and distinctiveness in one experimental situation.

White and Thomas analyzed approximately 9000 unretouched flake tools manufactured over a two week period by eighteen people in the Highlands of New Guinea. These people belong to two parishes, Aluni and Hareke, within the Duna speaking group. The study was conducted to ascertain:

> (i) The variations in the definition of an artifact class that artisans will allow from day to day.
>
> (ii) The variations that occur between the classifications made by different members of a socially conscious face to face group, within the space of two weeks.
>
> (iii) The variations that exist between artifacts which are similarly classified by two face to face groups who speak the same language. (White and Thomas 1972:284)

These classifications are based upon the division of unretouched flake tools into two basic categories: <u>aré</u> and <u>aré kou</u>. <u>Aré</u> are defined as flake tools, whereas <u>aré kou</u> belong to a subclass of smaller flake tools within <u>aré</u>. The <u>aré</u> <u>kou</u> are hafted while the others are hand held. These types are selected from amongst the debitage that results from smashing nodules. White and Thomas were interested in determining the differences, if any, in the selection of flake tools within and between the Aluni and Hareke through time. Since the flakes result from nodule smashing, the details of manufacture for each flake, such as force of blow, direction of force, and characteristics of core, are irrelevant. White and Thomas were focusing upon those individual and group templates that every member of the experiment had about what to select as acceptable <u>aré</u> or <u>aré</u> <u>kou</u>. They were able to demonstrate significant differences or changes in both temporal and between-group variation.

Their discussion of individual variation within each group was most interesting. White and Thomas (1972:298) noted: "In the sphere of individual variation our analysis clearly shows that there are considerable differences between the artifacts produced by each individual within each parish." This supports the proposition that there is sufficient and distinct product uniformity related to each manufacturer. Idiosyncratic variation, then, is both present and recognizable within this assemblage of lithic artifacts.

While White and Thomas did not present any way of evaluating the degree of idiosyncratic variation and distinctness amongst their knappers, I have found it possible to measure this distinctness by reworking their data using pairwise comparisons. It seemed that the best way to evaluate the distinctness of each knapper was to compare him to only one other knapper at a time. This would permit the observation of the distinctness of each knapper relative to every other one in the experiment. Since all the knappers of each group share a cultural template for each tool type, overlapping ranges of variation would be expected. The use of pairwise comparisons to establish the distinctness of knappers is also important because this same approach is used to evaluate the distinctness on the individual level within the ceramic assemblages from Jugtown and Divostin.

In White and Thomas' study, six dimensions were recorded: length, width, thickness, edge angle, weight and length/breadth ratio. Each artifact is not directly used in the analysis but instead a "Type Man Day" (TMD). A TMD is "comprised of all the artifacts of a type [either aré or aré kou] produced by one man on a single day" (White and Thomas 1972:292). Thus, the data for the analysis represented the mean for each of the dimensions produced on a single day for each artifact type. This data was then analyzed by Principal Components Analysis. White and Thomas (1972:292) described the analytic procedure in the following manner:

> The analysis begins with a pxp correlation matrix, where p is the number of variables involved. Point representations—the date *per se*—are plotted in p dimensional space, usually forming ellipsoidal swarms of points. The principal components analysis involves the rotations of the coordinate axes in the variable space. The results describe the p original variables in terms of p new principal components. All the components are orthogonal to each other, i.e. they are statistically independent. In addition, each component accounts for a maximum amount of the variance of the variables. The first component accounts for the most variance . . . . The second component is responsible for the second amount of the variance and so on.

The principal components analysis scores each of the dimensions, variables, for its significance for each component. All those variables that receive high scores (either positive or negative) for a particular component are considered to be important in contributing to the total variation assumed by that component. In their first component, length, width, weight and thickness all received high scores. The first component, accounting for 68.7% of the total variance within the population of TMDs, is interpreted as general size. Thus, the principal components create new variables from the variation encountered in the original dimensions. The second component (accounting for 16.6%) showed a high score for only edge angle, and the third component (accounting for 13.2%) scored highly on length-breadth ratio. The first three components accounted for 98.5% of all the variation within the artifact population of <u>aré</u> and <u>aré kou</u>.[1]

Each TMD for each component also received a score. These scores were then used to plot the TMDs in two dimensional space with the x and y axes receiving component labels. This resulted in a series of plots using Components 1 and 2, Components 1 and 3, Components 2 and 3, and so on, until all the variation within the population of TMDs was accounted for, total variation equalling 100%. In practice, however, limits are set as to how many plots are produced as each successive component accounts for smaller proportions of the total variation. These limits are usually determined by the number of components which are necessary to account for a specified portion of the total variation, usually 95%.

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[1]A number of criticisms have been raised concerning the interpretation of th components in the White and Thomas (1972) study. Thomas (1977) has reinterpreted the components. Component 2, originally labeled as width, is now edge angle. Component 3, originally listed as edge angle, is now interpreted as length-breadth ratio and length. These reinterpretations do not effect the use of White and Thomas' data. In the discussion above I am using the corrected interpretations as suggested by Thomas in his later paper (1977).

White and Thomas provided the data for each individual in the form of plots where the components are used to define the x and y axes. They only presented two sets of plots for each individual in the study. The first showed Component 1 (size-x axis) and Component 2 (edge angle-y axis). The second set of plots again uses Component 1 along the x axis and Component 3 (length-breadth ratio) along the y axis.

Pairwise comparisons were made using the knappers from only the Aluni parish. The Aluni were selected because they each had a greater number of TMDs than the Hareke group. Therefore, the Aluni knappers would provide a more meaningful evaluation of idiosyncratic patterning and distinctiveness. The larger number of TMDs for each Aluni would also provide a more accurate picture of the range of variation for each producer and therefore reduce the problem of sampling error. Two of the eight knappers, those designated Aluni 5 and Aluni 7, were partially removed from the analysis. Aluni 5 produced only two TMDs for _aré_. It was felt that these two points would not adequately reflect the possible range of variation produced by this knapper for this tool type. Therefore, pairwise comparisons of _aré_ were not conducted for Aluni 5. Similarly, Aluni 7 was partially removed from the test of _aré_. Aluni 7 did not produce any TMDs for _aré_, so he, too, was eliminated from pairwise comparisons involving _aré_. The number of TMDs for each tool type for each knapper is shown in table 1. Additionally, the symbol adjacent to each name will be the symbol used in the diagrams of pairwise comparisons. Thus, the smaller sample of knappers of _aré_ allows for 15 pairwise comparisons, and the larger sample of knappers of _aré kou_ allows for 28 comparisons. The diagrams depicting the distribution of points for both tool types, aré and aré kou, are shown in figures 1-56. The cluster of points to the right of the straight line represent aré, and the cluster of points to the left of the straight line indicate aré kou.

The degree of distinctness between any two knappers can be scored as either distinct (D) or non-distinct (ND). A knapper's tools (TMDs) are determined to be distinct if a majority of his tools fall outside the range of the other producer within the comparison. This majority measure was chosen arbitrarily. However, the results of the analysis indicate that knappers were distinct well beyond this cutoff point. Since overlapping of tools is expected from the shared cultural template, a majority of points outside the range of the other knapper seems to be meaningful evidence of distinctness. An examination of the diagrams of the comparisons reveals in most cases that far more than a majority of points are distinct (figures 1-56). The results of these comparisons are summarized in table 2.

The first set of data, Components 1 and 2, compares size, shown as the x-axis variable, and edge angle shown as the y-axis variable. Figures 1-28 show the pairwise comparisons for both tool types. Columns 1 (aré kou) and 2 (aré) of Table 2 summarize the results of the comparisons. Distinctness is established in 78.6%, 22 of 28, comparisons for aré kou. Aré shows a larger percentage of pairwise distinctiveness, 100%, as all 15 comparisons are distinct. The pairwise comparisons for Components 1 (size, x-axis) and 3 (length-breadth ratio, y-axis), are shown in figures 29-56 and summarized in table 2, columns 3 and 4. Significant distinctions are shown in 67.9%, 19 of 28 comparisons, for aré kou, and 86.7%, as 13 of 15 comparisons, for aré.

TABLE 1

DISTRIBUTION OF TMDS FOR ALUNI KNAPPERS

	<u>Aré</u> <u>kou</u>	<u>Aré</u>
Aluni 1 (●)	6	5
Aluni 2 (★)	8	6
Aluni 3 (□)	7	6
Aluni 4 (○)	6	5
Aluni 5 (✫)	8	2*
Aluni 6 (✪)	5	4
Aluni 7 (➚)	6	0**
Aluni 8 (▲)	8	8

*Aluni 5 was not used in the pairwise comparisons of <u>aré</u> because the <u>N</u> was too small to allow for significant evaluation.

**Aluni 7 was not used in the pairwise comparison because he did not produce any TMDs for this tool type.

These results refine and support the conclusions of White and Thomas. The comparisons involving <u>aré</u> clearly warrant their use of the words "considerable differences," whereas the comparisons involving the use of <u>aré</u> <u>kou</u> do not discriminate as clearly and the use of the words "considerable differences" appears excessive. It appears from this analysis that <u>aré</u> TMDs are more sensitive indicators of idiosyncratic patterning than <u>aré</u> <u>kou</u>. It must be remembered that both tool types achieved distinctiveness in 67% or more of the tests.

The lack of distinctiveness in some of the comparisons can be more clearly understood if an examination of the individuals was made with regard to their idiosyncratic patterning. It seems from the results of the pairwise comparisons that certain individuals show greater ranges of variation in their material objects than do other

TABLE 2

SUMMARY OF PAIRWISE COMPARISONS FOR THE ALUNI KNAPPERS

	Components 1 and 2		Components 1 and 3	
	aré kou (1)	aré (2)	aré kou (3)	aré (4)
Knappers				
1-2	D	D	D	D
1-3	D	D	D	D
1-4	D	D	D	D
1-5	D	*	D	*
1-6	D	D	D	D
1-7	D	*	D	*
1-8	D	D	D	D
2-3	D	D	D	ND
2-4	ND	D	ND	D
2-5	D	*	D	*
2-6	D	D	D	D
2-7	ND	*	ND	*
2-8	ND	D	ND	D
3-4	D	D	D	D
3-5	D	*	ND	*
3-6	D	D	ND	D
3-7	D	*	D	*
3-8	D	D	D	ND
4-5	D	*	D	*
4-6	D	D	D	D
4-7	ND	*	ND	*
4-8	ND	D	ND	D
5-6	D	*	ND	*
5-7	D	*	D	*
5-8	D	*	D	*
6-7	D	*	D	*
6-8	D	D	D	D
7-8	ND	*	ND	*
Totals				
D	22	15	19	13
ND	6	0	9	2
*	0	13	0	13

KEY: D = distinctness established with more than 50% of all points of one knapper outside the range of the other knapper, ND = distinctness not established, and * = no comparisons made.

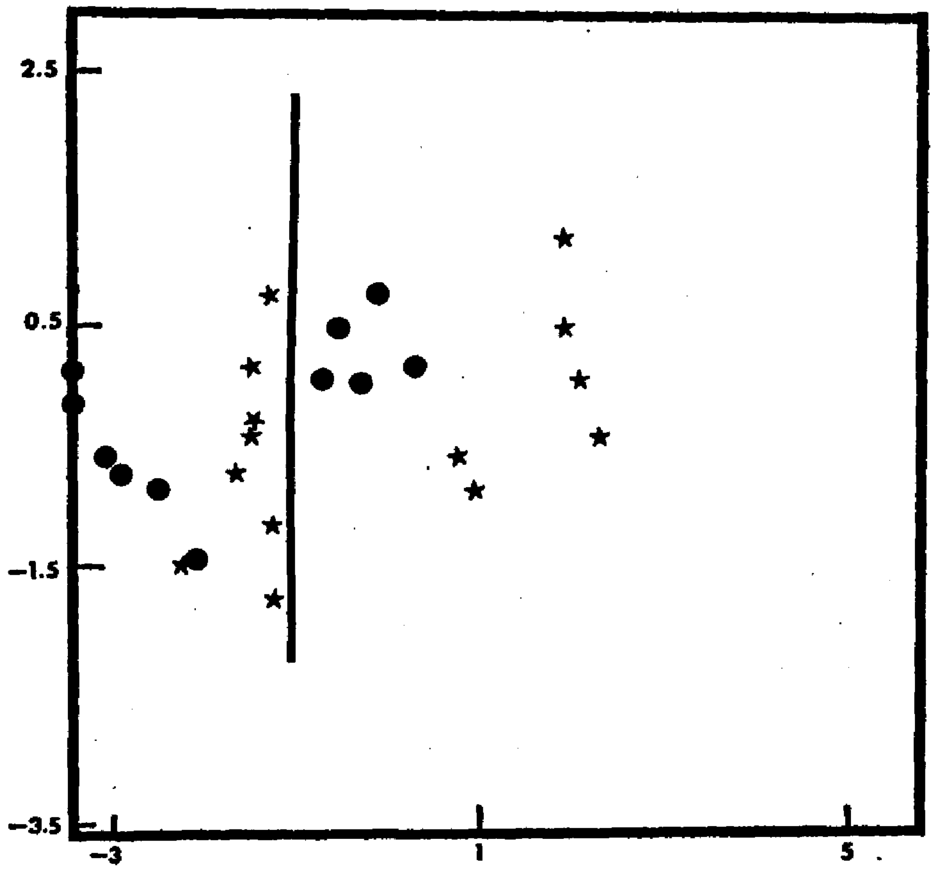

Fig. 1. Comparison of Aluni 1 (closed circle) and Aluni 2 (closed star) using Components 1 and 2.

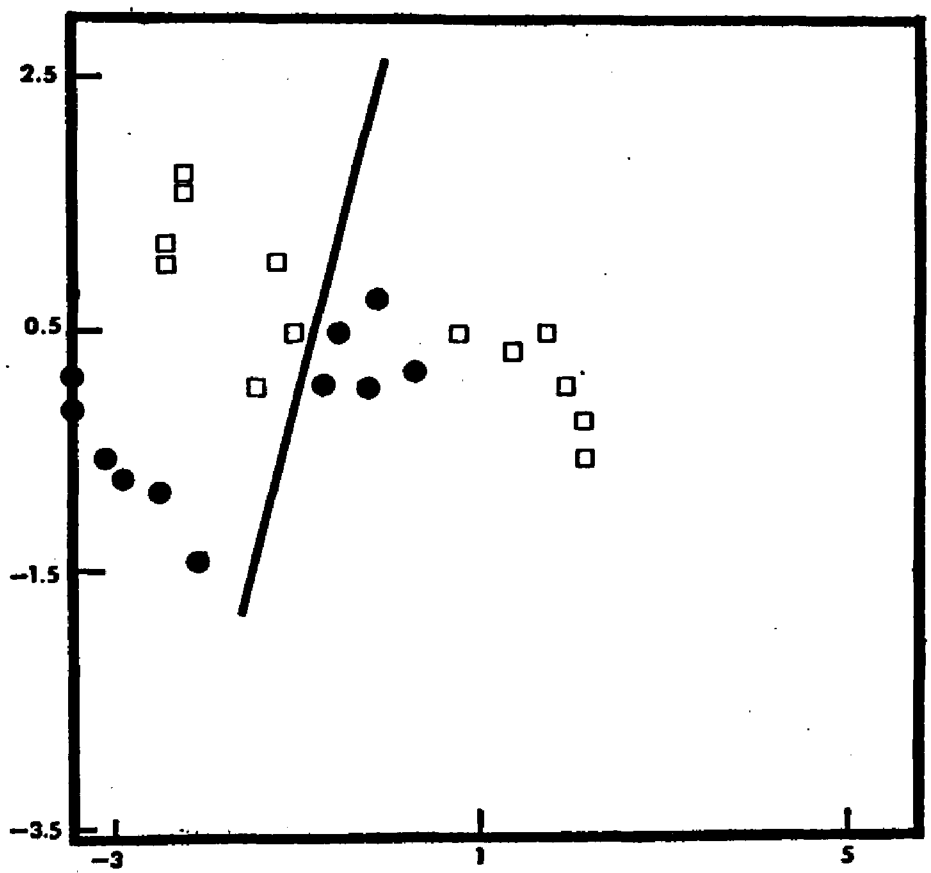

Fig. 2. Comparison of Aluni 1 (closed circle) and Aluni 3 (square) using Components 1 and 2.

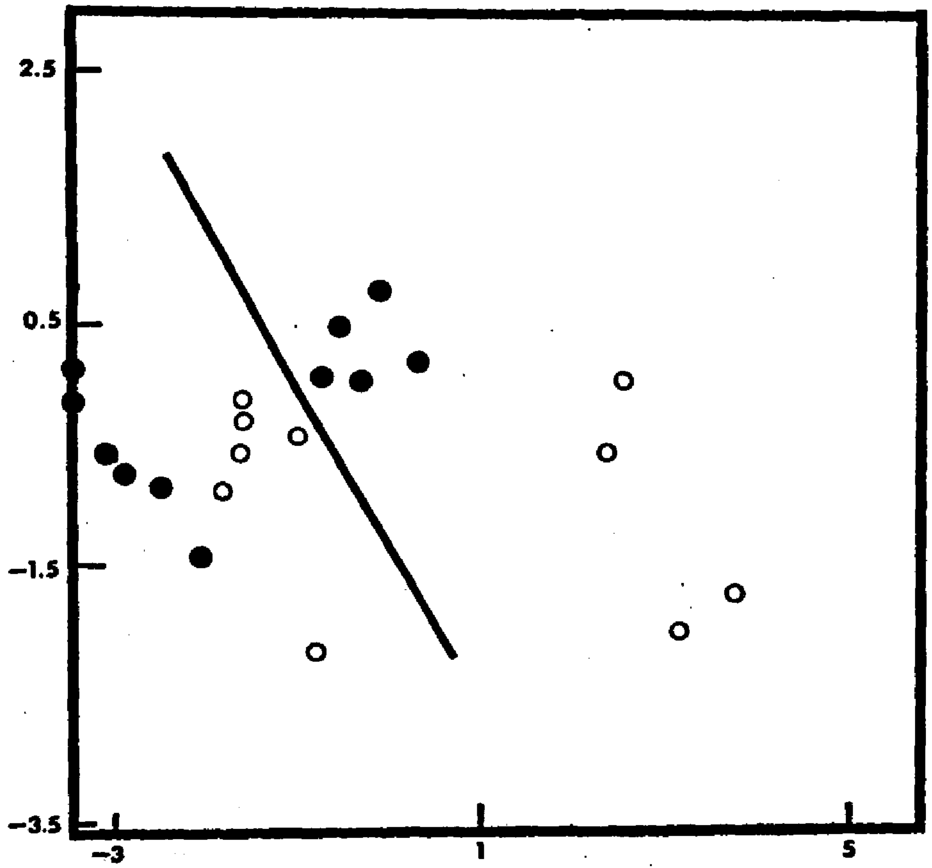

Fig. 3. Comparison of Aluni 1 (closed circle) and Aluni 4 (opened circle) using Components 1 and 2.

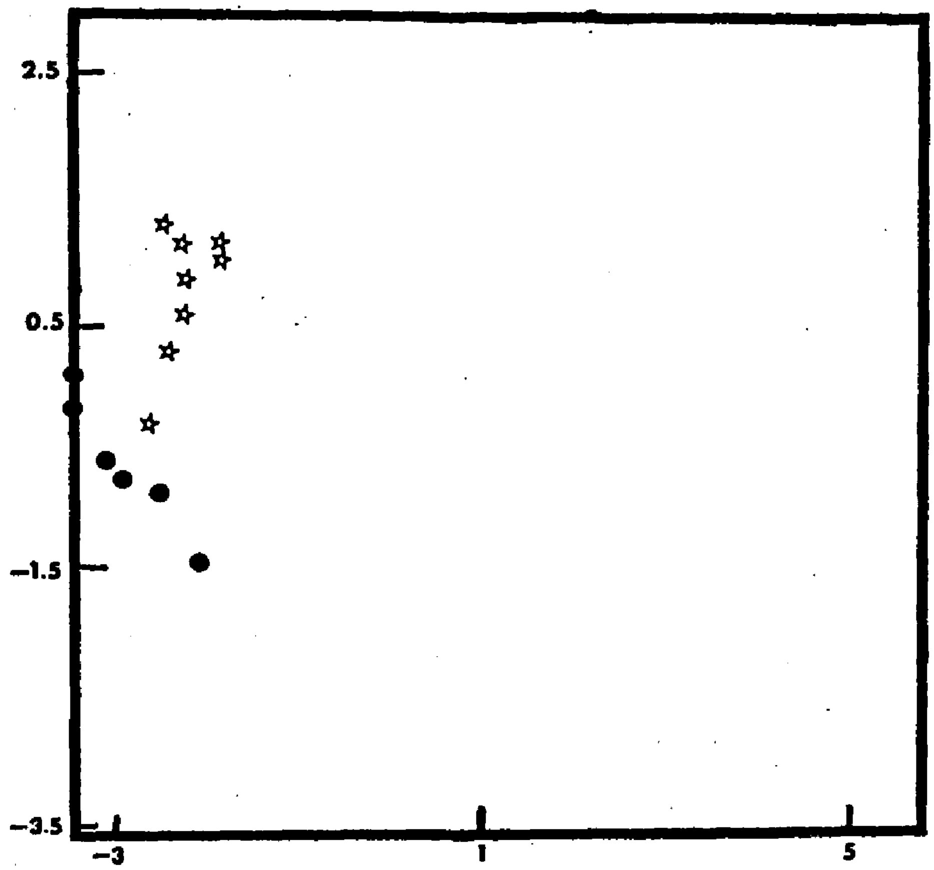

Fig. 4. Comparison of Aluni 1 (closed circle) and Aluni 5 (opened star) using Components 1 and 2.

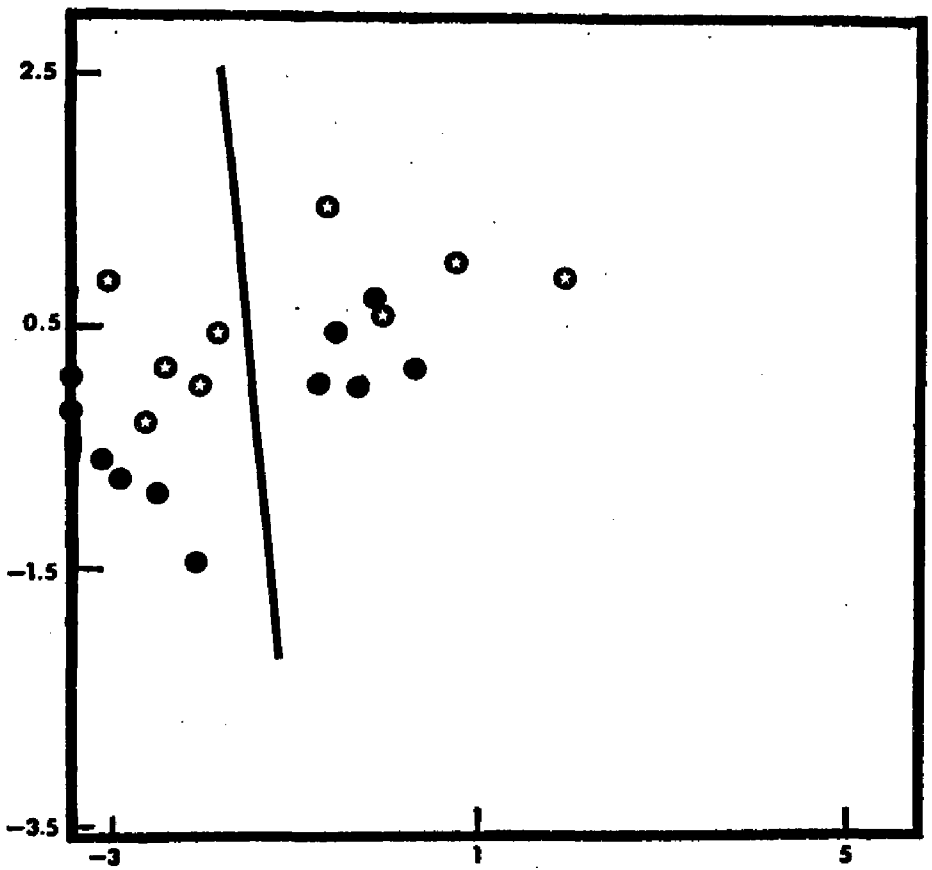

Fig. 5. Comparison of Aluni 1 (closed circle) and Aluni 6 (circled star) using Components 1 and 2.

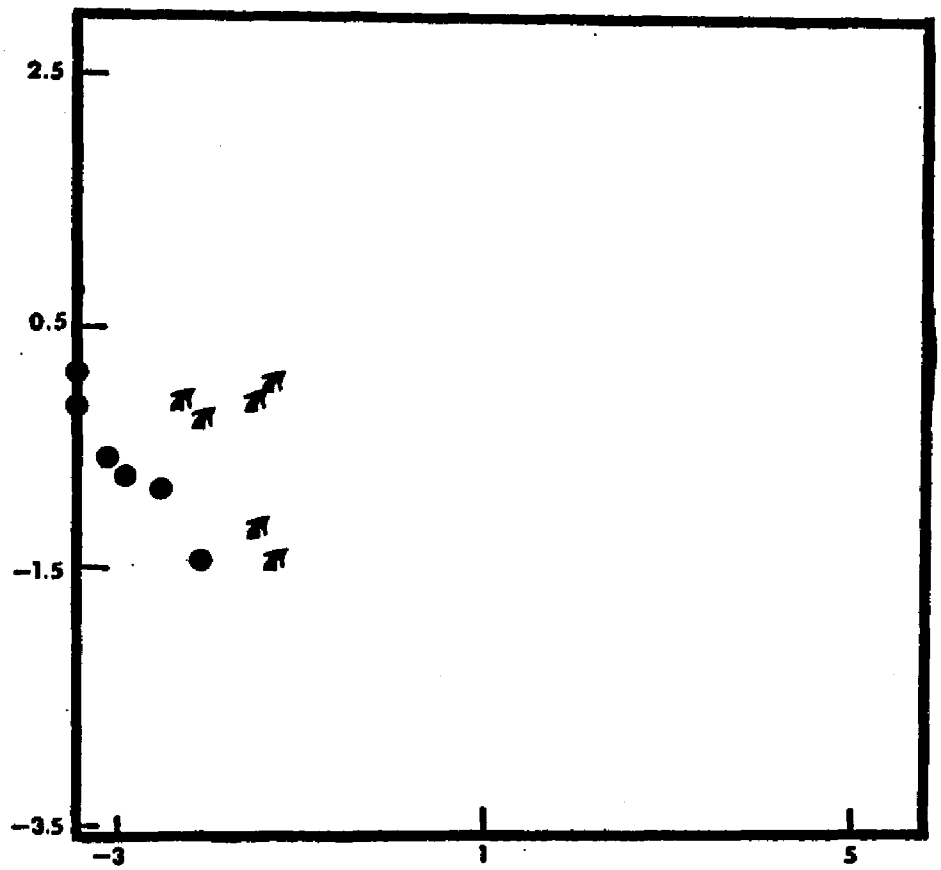

Fig. 6. Comparison of Aluni 1 (closed circle) and Aluni 7 (arrow) using Components 1 and 2.

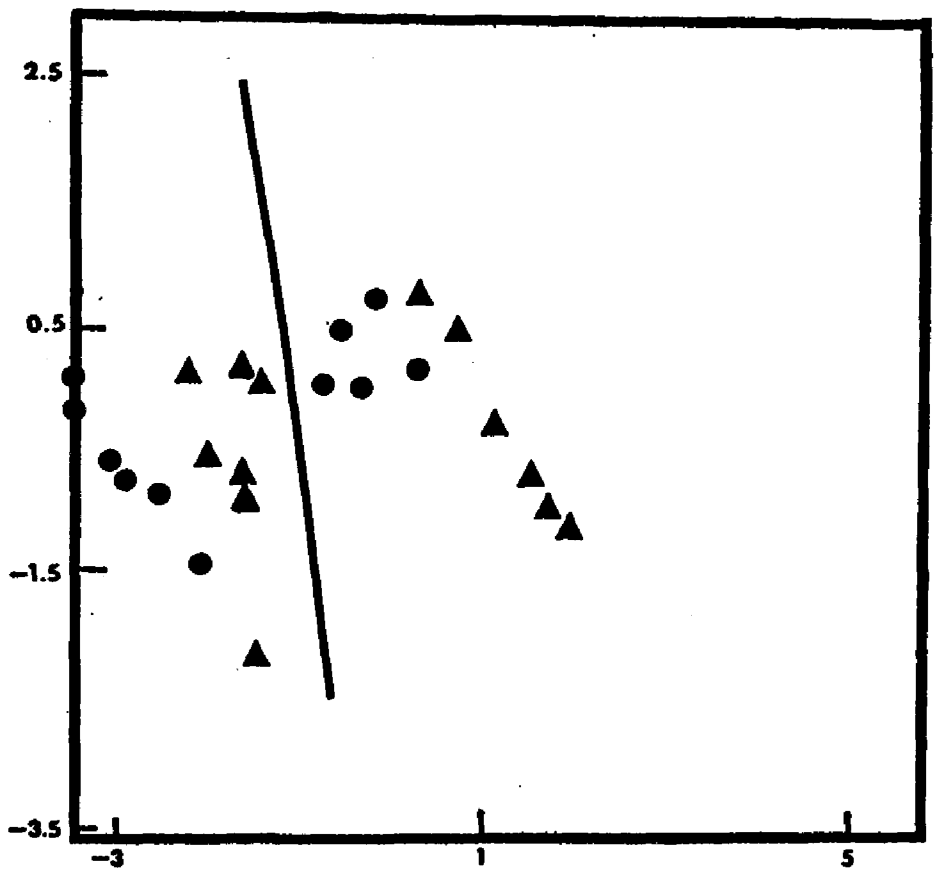

Fig. 7. Comparison of Aluni 1 (closed circle) and Aluni 8 (triangle) using Components 1 and 2.

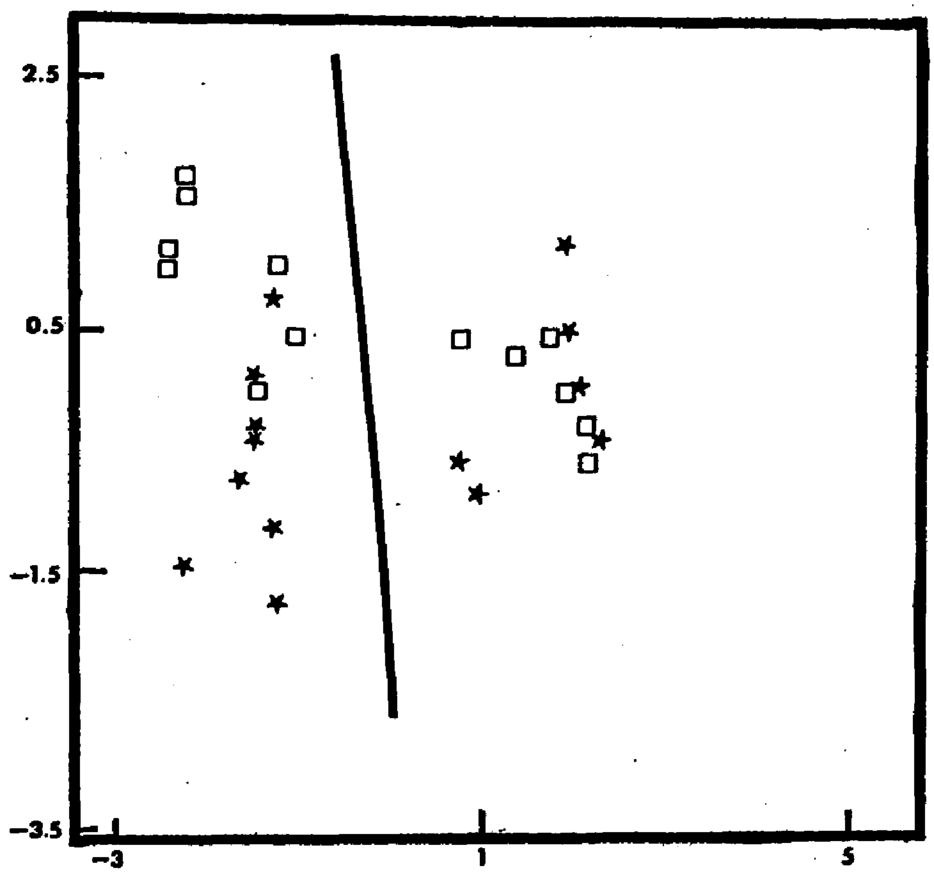

Fig. 8. Comparison of Aluni 2 (closed star) and Aluni 3 (square) using Components 1 and 2.

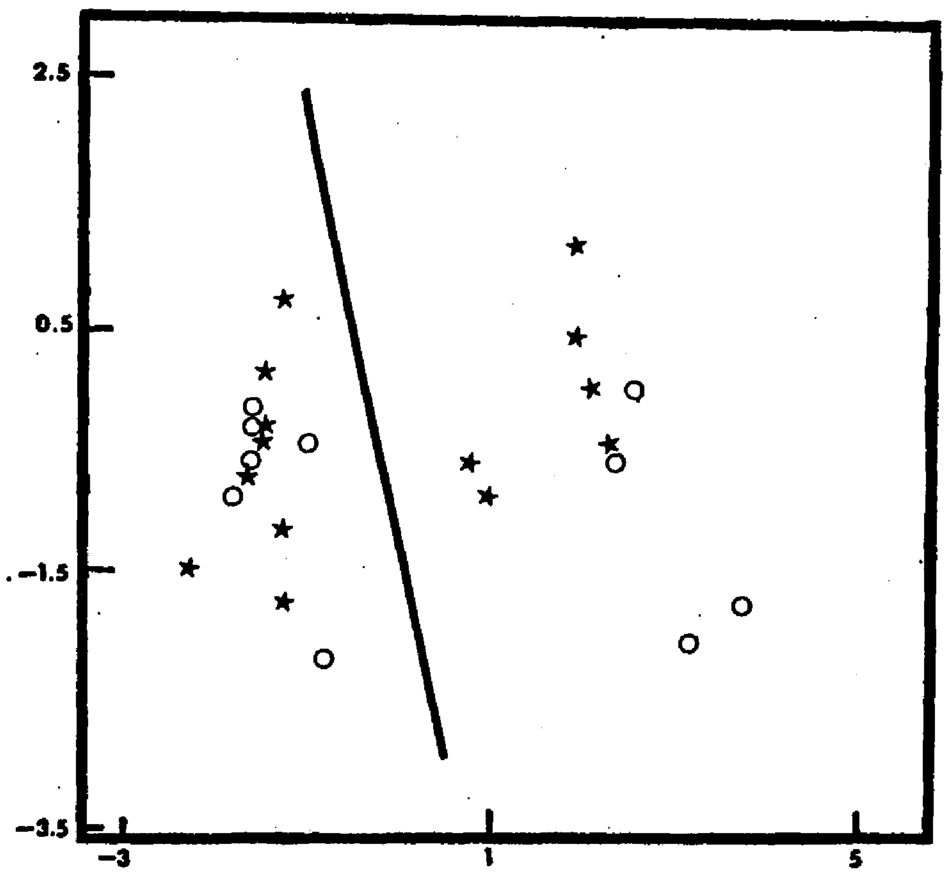

Fig. 9. Comparison of Aluni 2 (closed star) and Aluni 4 (opened circle) using Components 1 and 2.

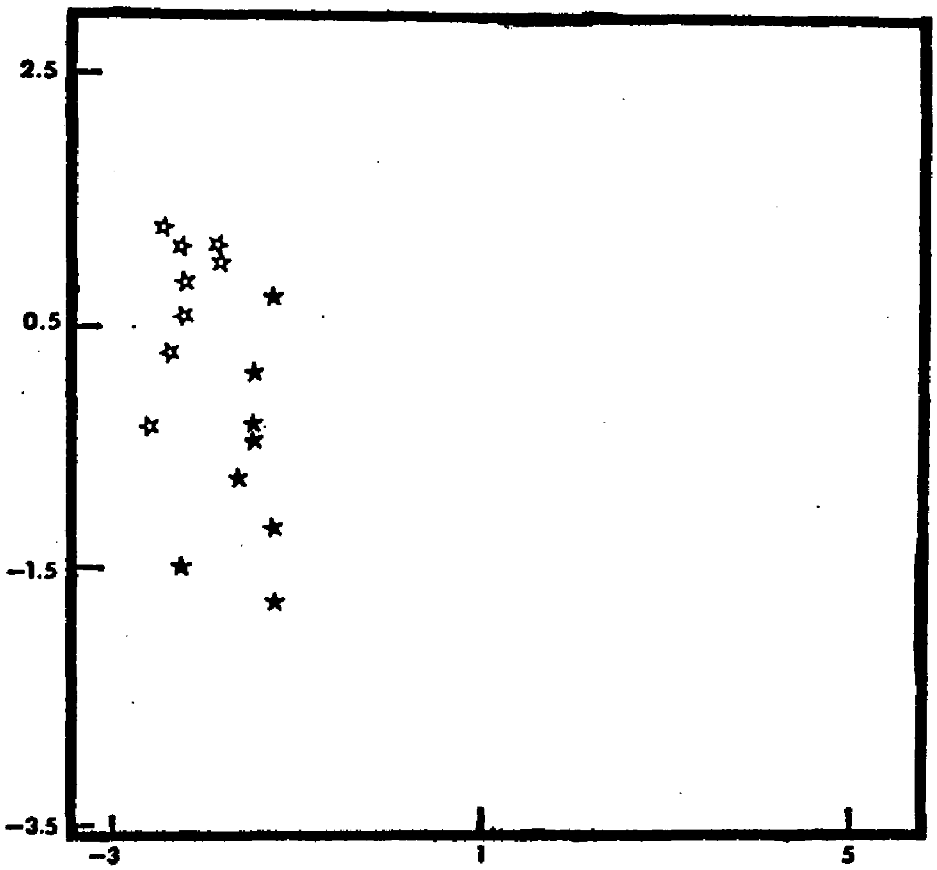

Fig. 10. Comparison of Aluni 2 (closed star) and Aluni 5 (opened star) using Components 1 and 2.

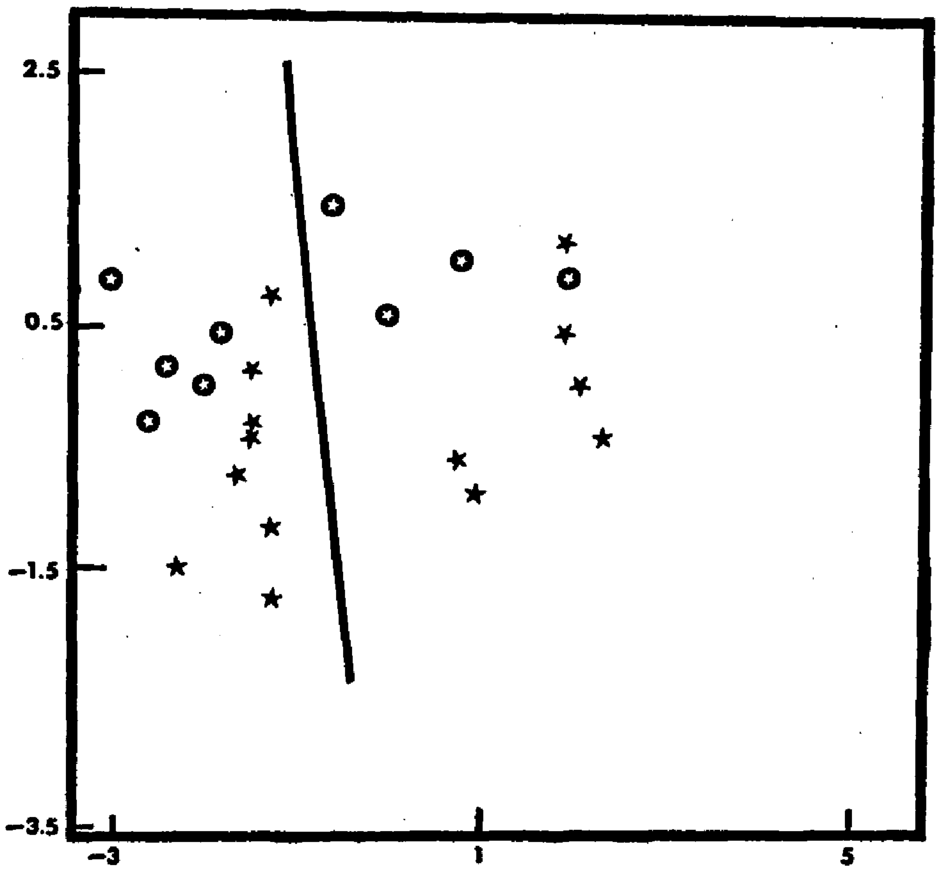

Fig. 11. Comparison of Aluni 2 (closed star) and Aluni 6 (circled star) using Components 1 and 2.

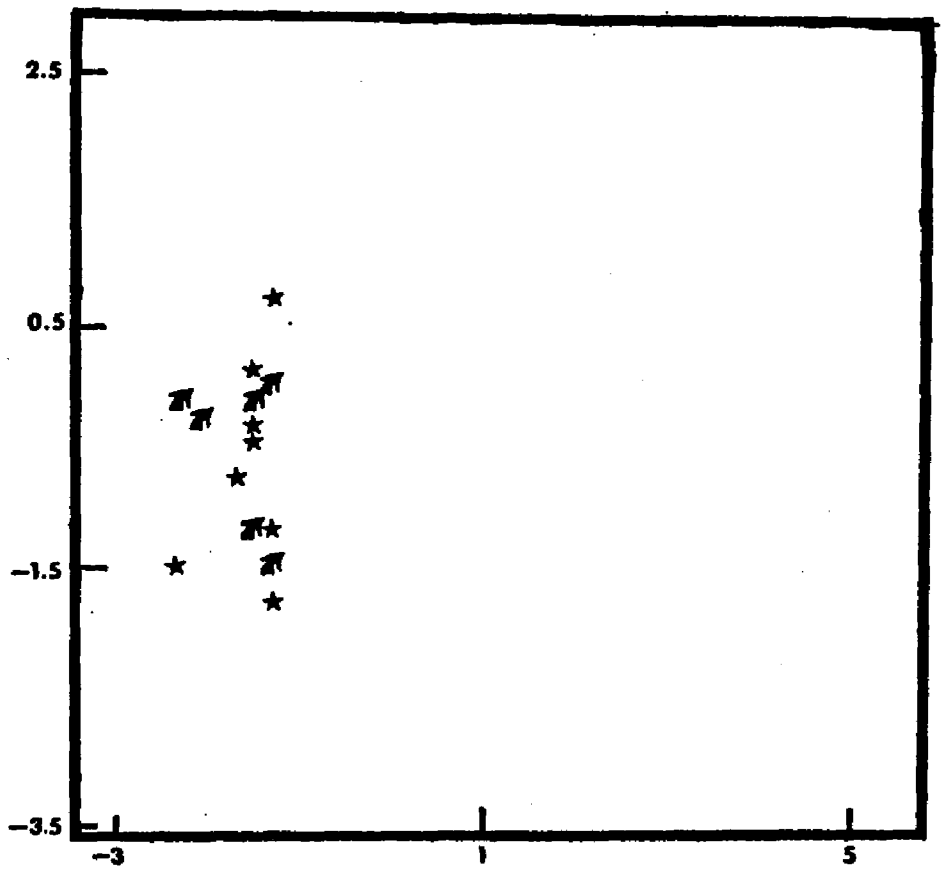

Fig. 12. Comparison of Aluni 2 (closed star) and Aluni 7 (arrow) using Components 1 and 2.

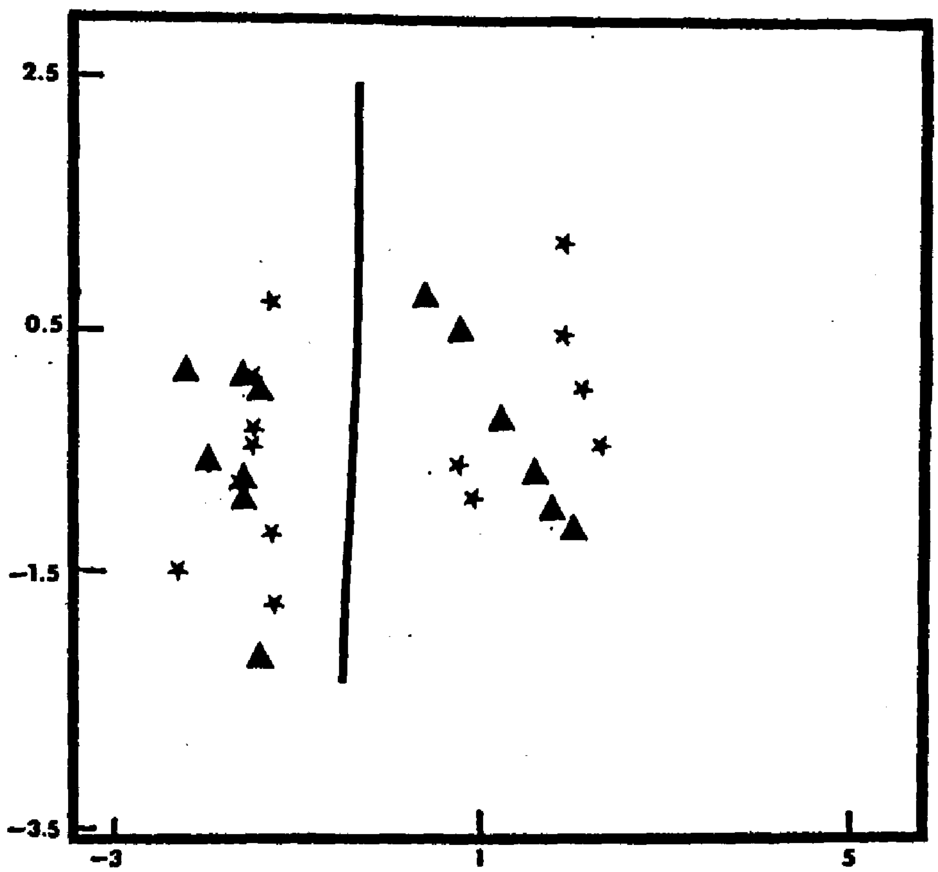

Fig. 13. Comparison of Aluni 2 (closed star) and Aluni 8 (triangle) using Components 1 and 2.

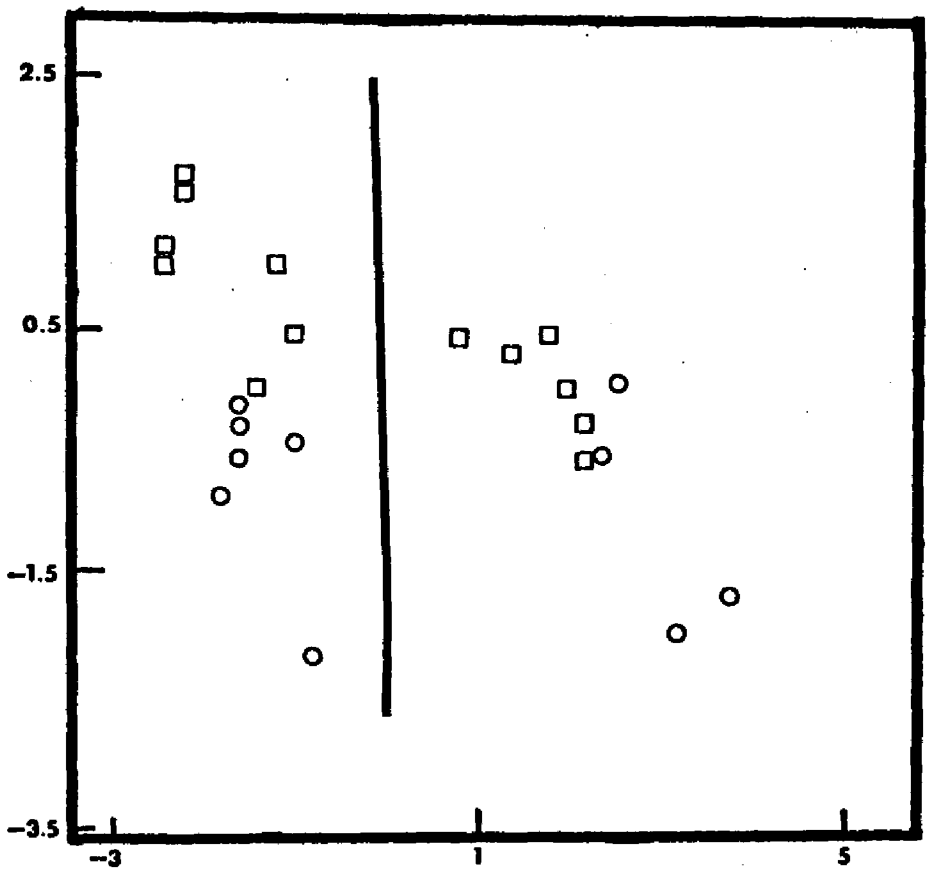

Fig. 14. Comparison of Aluni 3 (square) and Aluni 4 (opened circle) using Components 1 and 2.

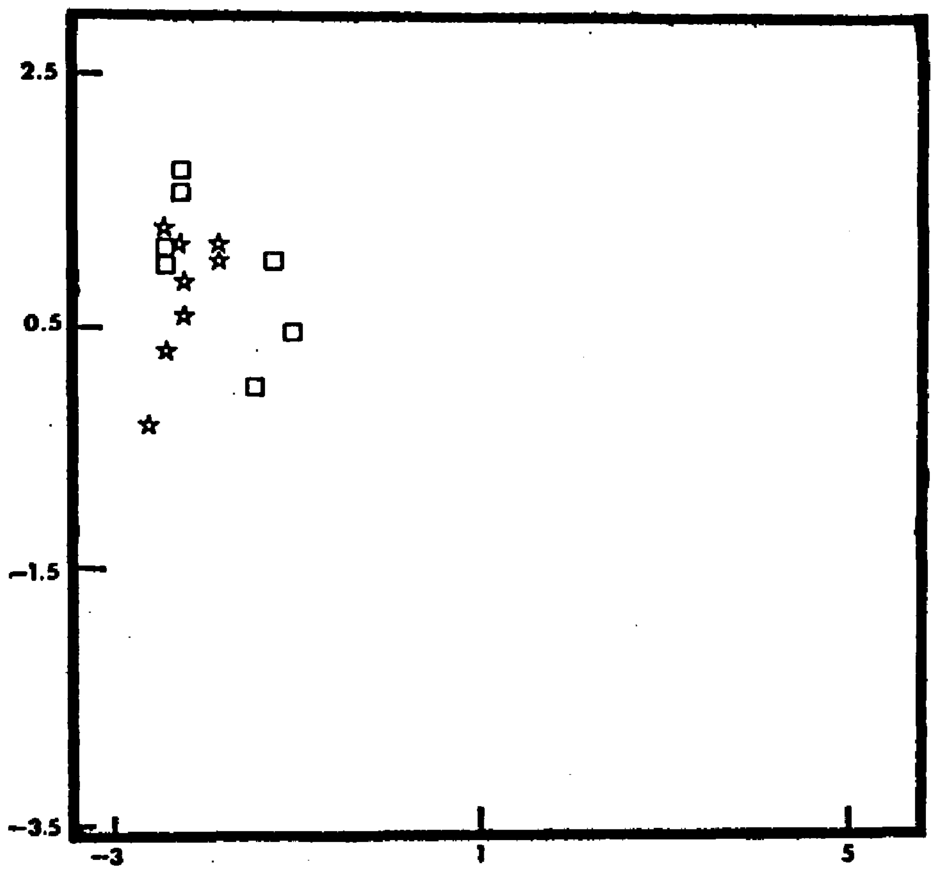

Fig. 15. Comparison of Aluni 3 (square) and Aluni 5 (opened star) using Components 1 and 2.

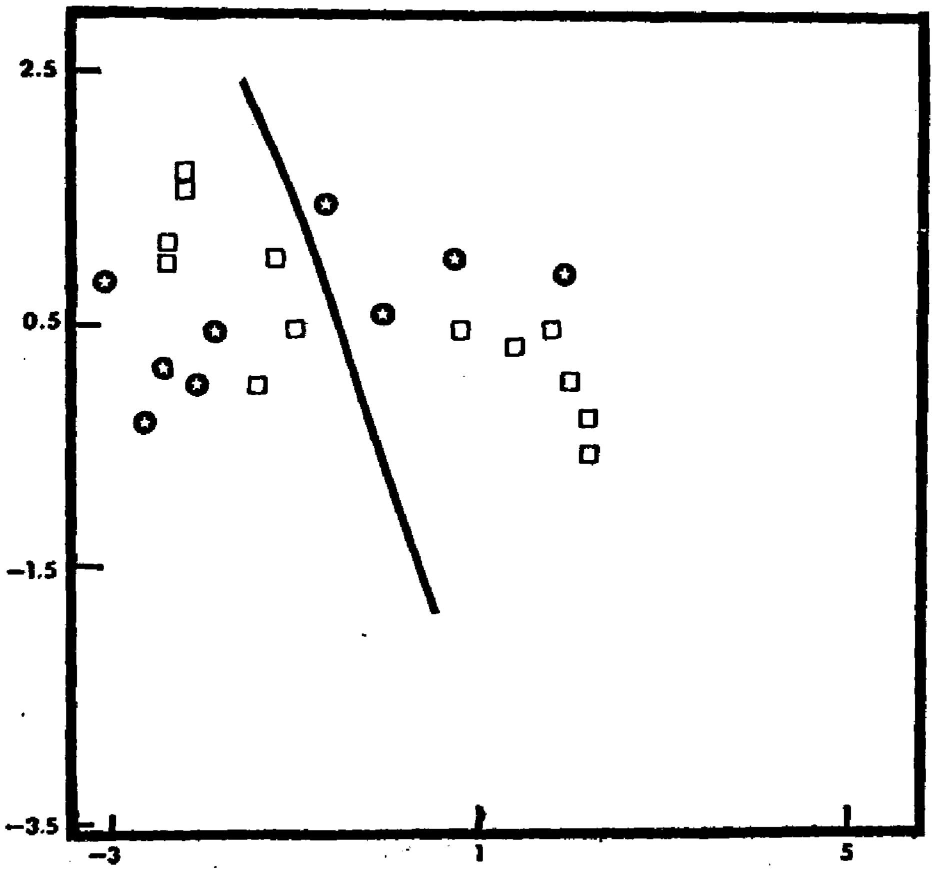

Fig. 16. Comparison of Aluni 3 (square) and Aluni 6 (circled star) using Components 1 and 2.

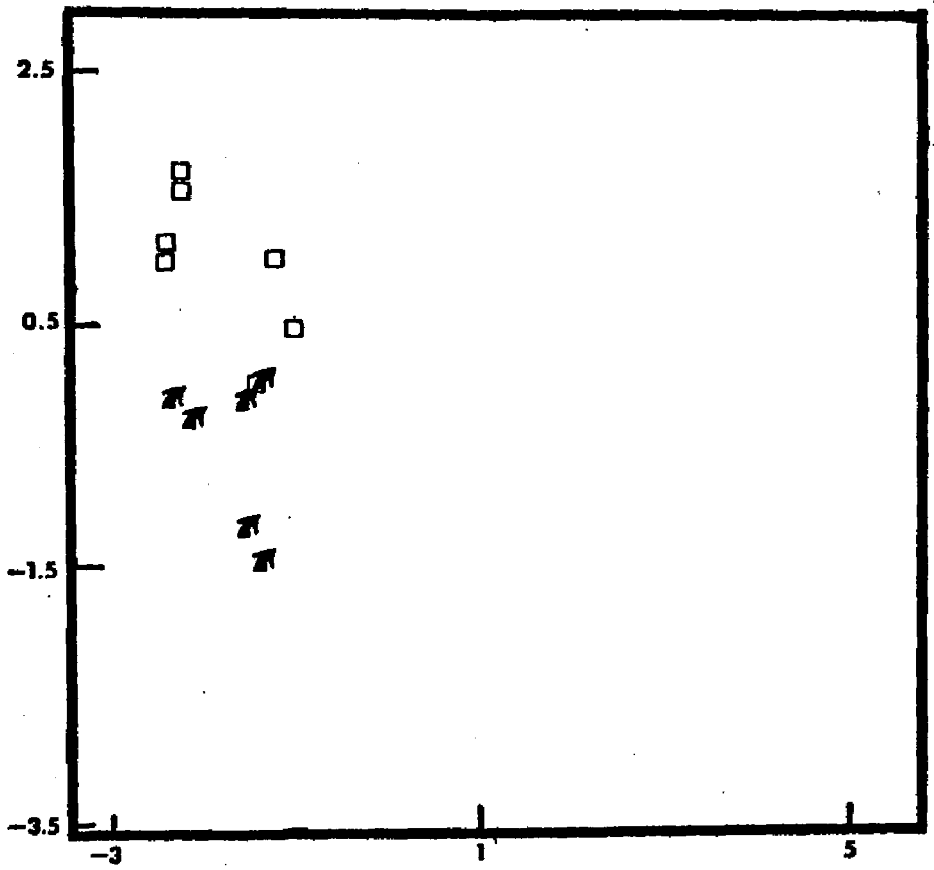

Fig. 17. Comparison of Aluni 3 (square) and Aluni 7 (arrow) using Components 1 and 2.

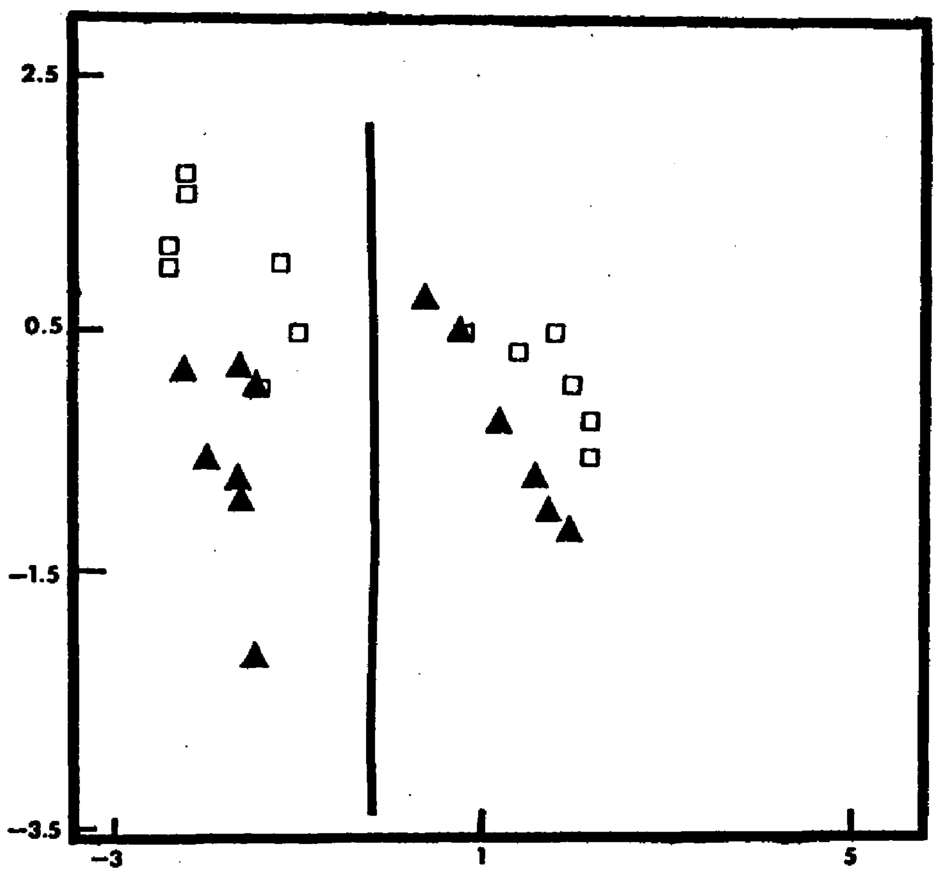

Fig. 18. Comparison of Aluni 3 (square) and Aluni 8 (triangle) using Components 1 and 2.

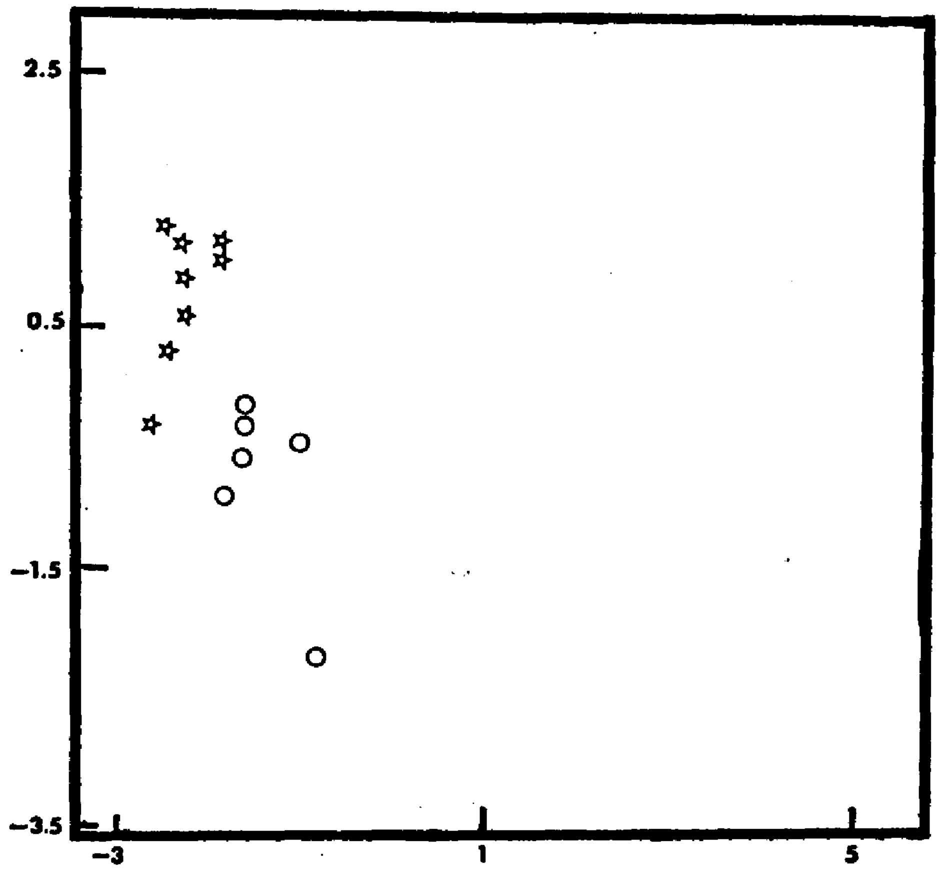

Fig. 19. Comparison of Aluni 4 (opened circle) and Aluni 5 (opened star) using Components 1 and 2.

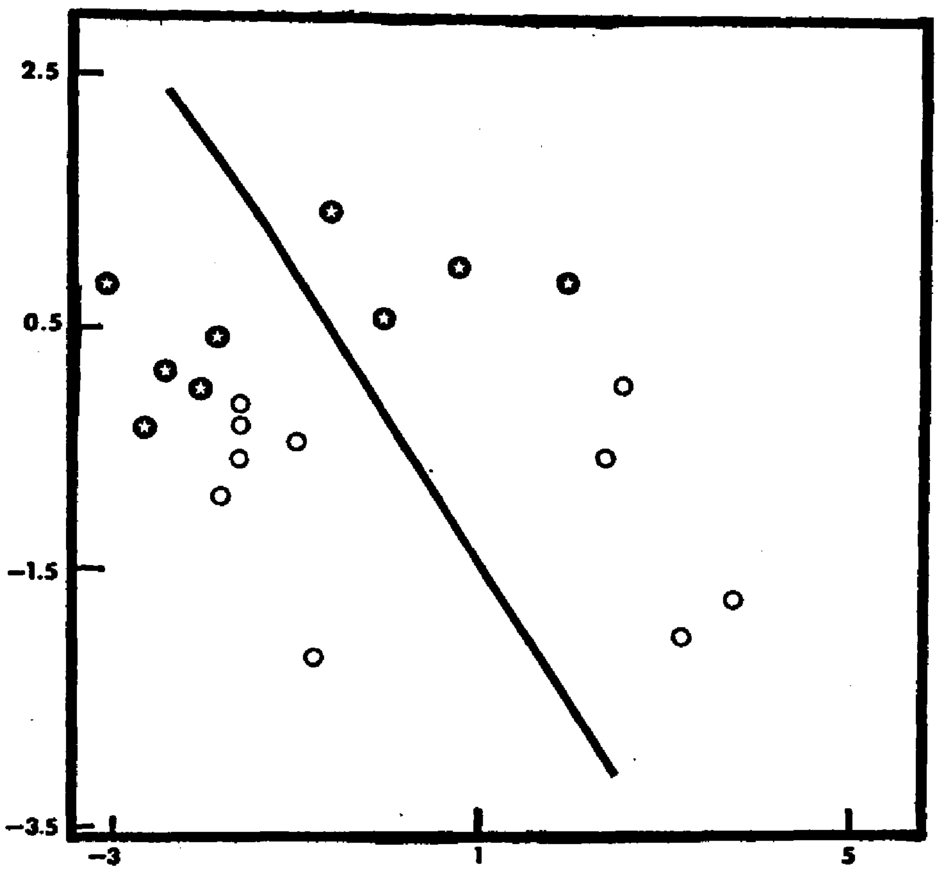

Fig. 20. Comparison of Aluni 4 (opened circle) and Aluni 6 (circled star) using Components 1 and 2.

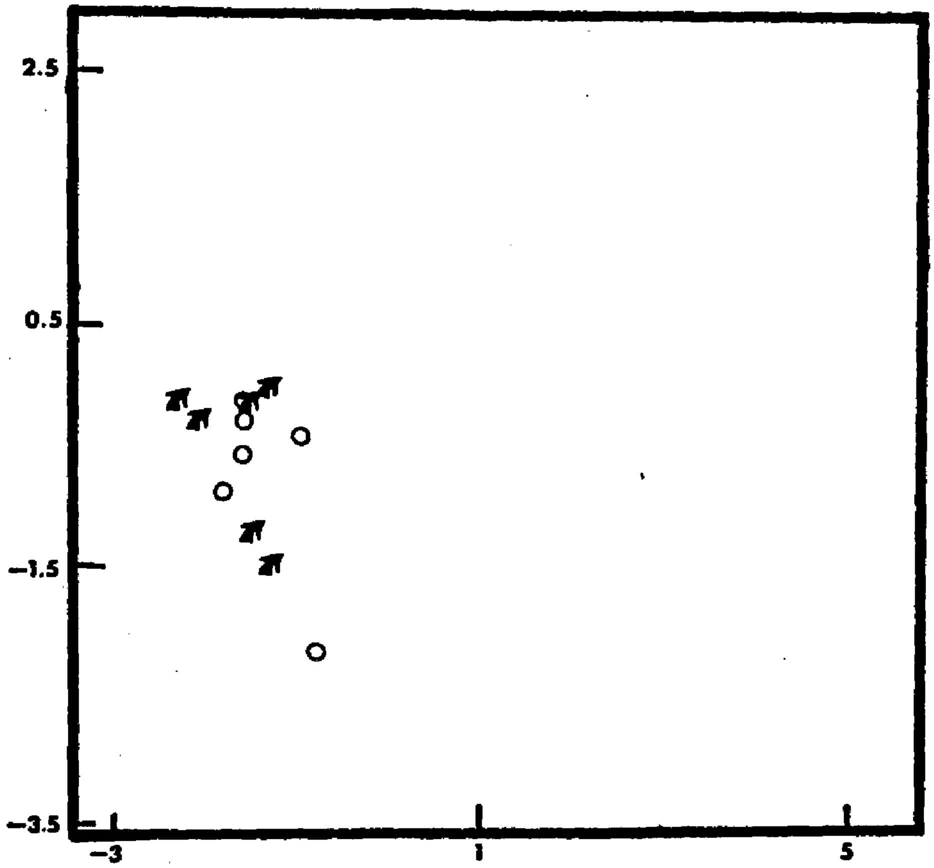

Fig. 21. Comparison of Aluni 4 (opened circle) and Aluni 7 (arrow) using Components 1 and 2.

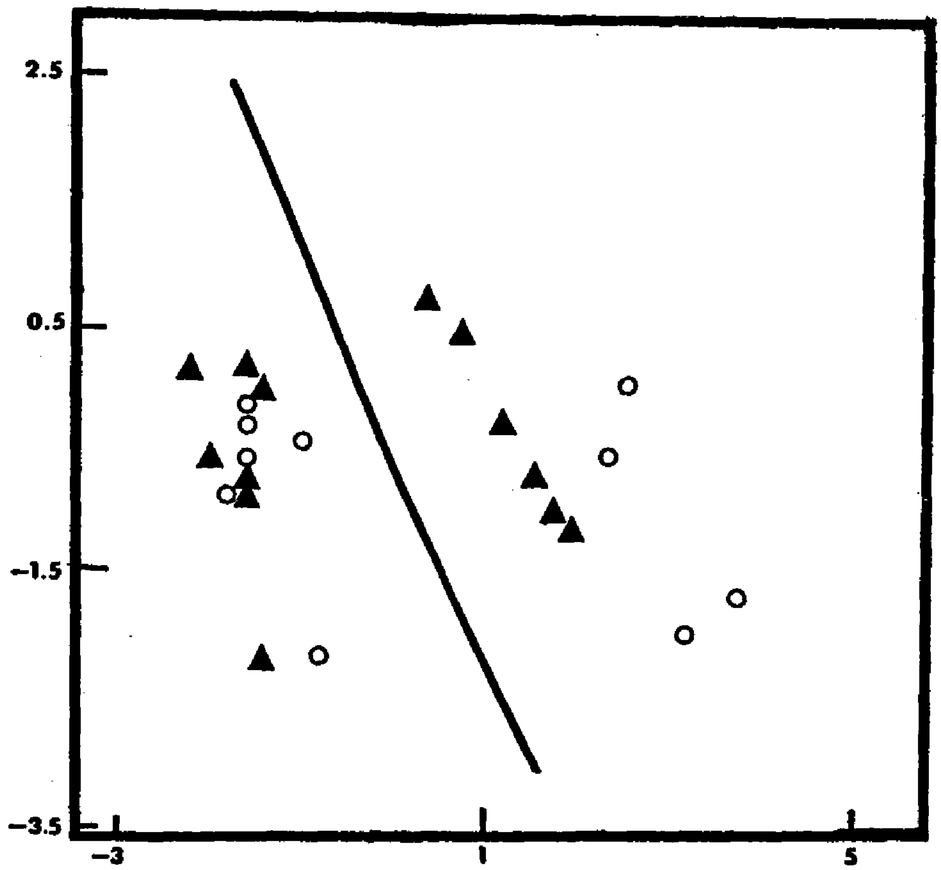

Fig. 22. Comparison of Aluni 4 (opened circle) and Aluni 8 (triangle) using Components 1 and 2.

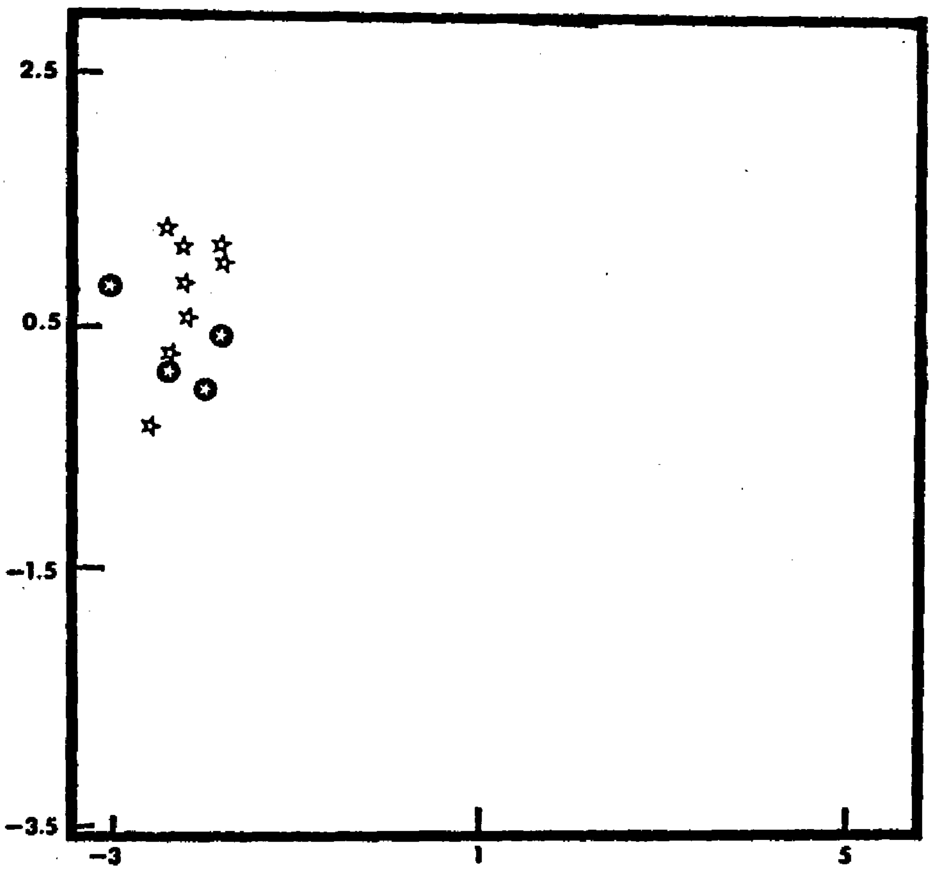

Fig. 23. Comparison of Aluni 5 (opened star) and Aluni 6 (circled star) using Components 1 and 2.

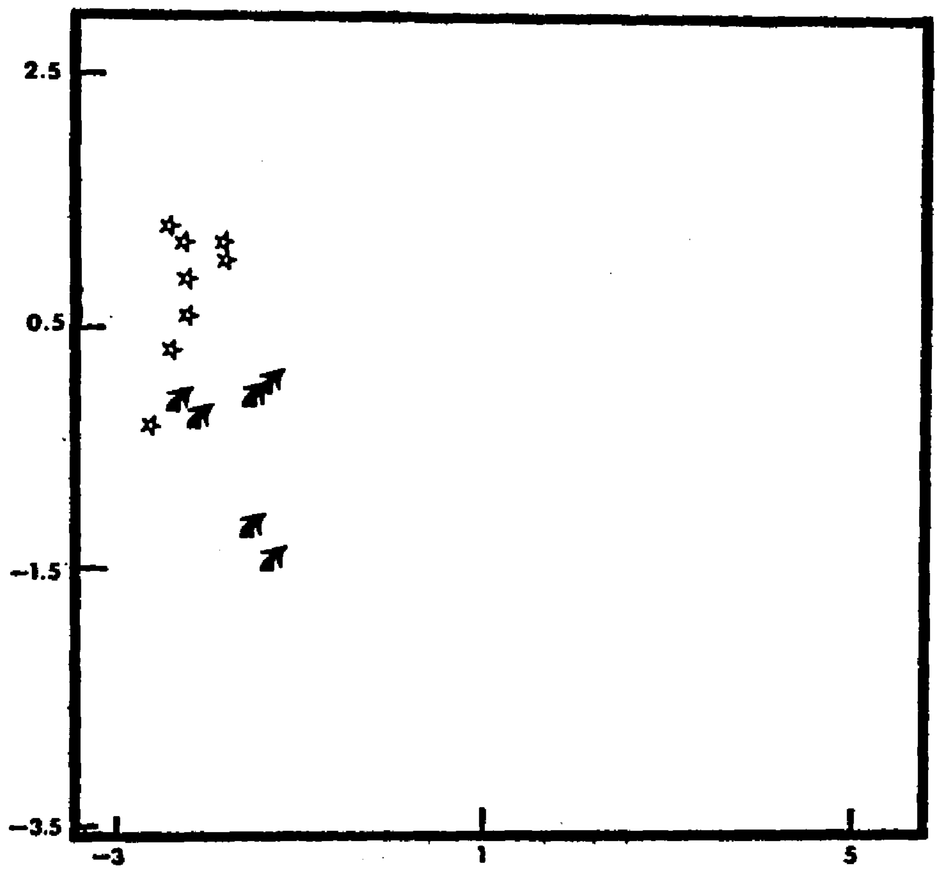

Fig. 24. Comparison of Aluni 5 (opened star) and Aluni 7 (arrow) using Components 1 and 2.

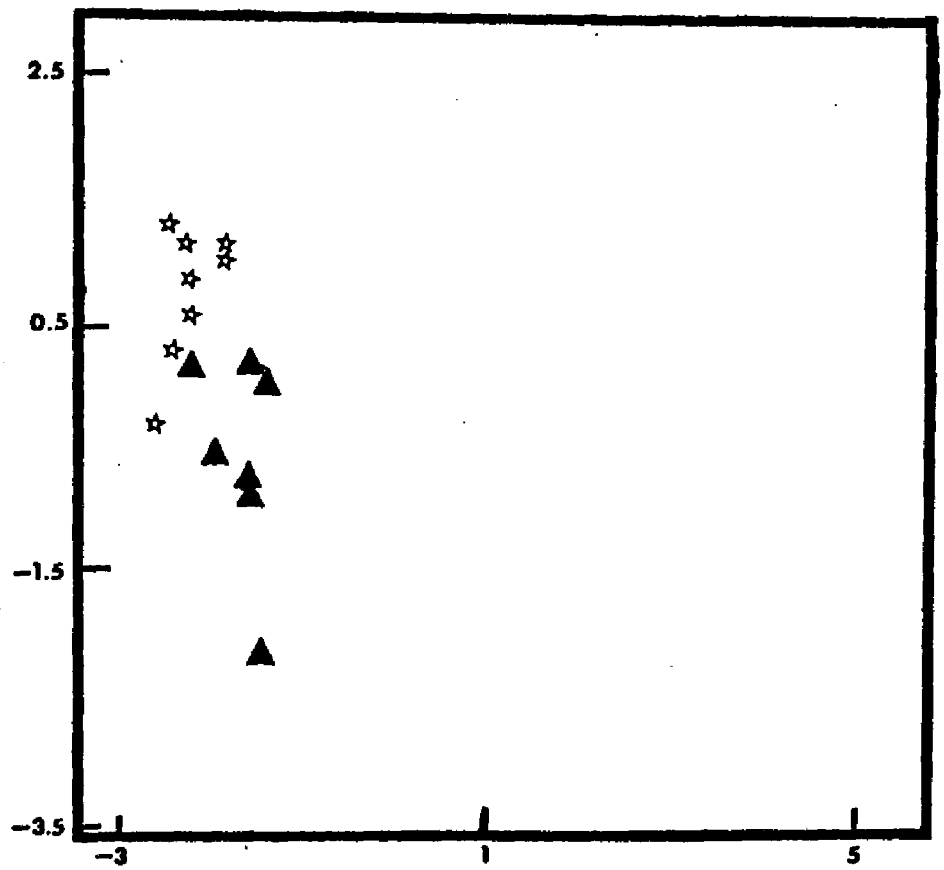

Fig. 25. Comparison of Aluni 5 (opened star) and Aluni 8 (triangle) using Components 1 and 2.

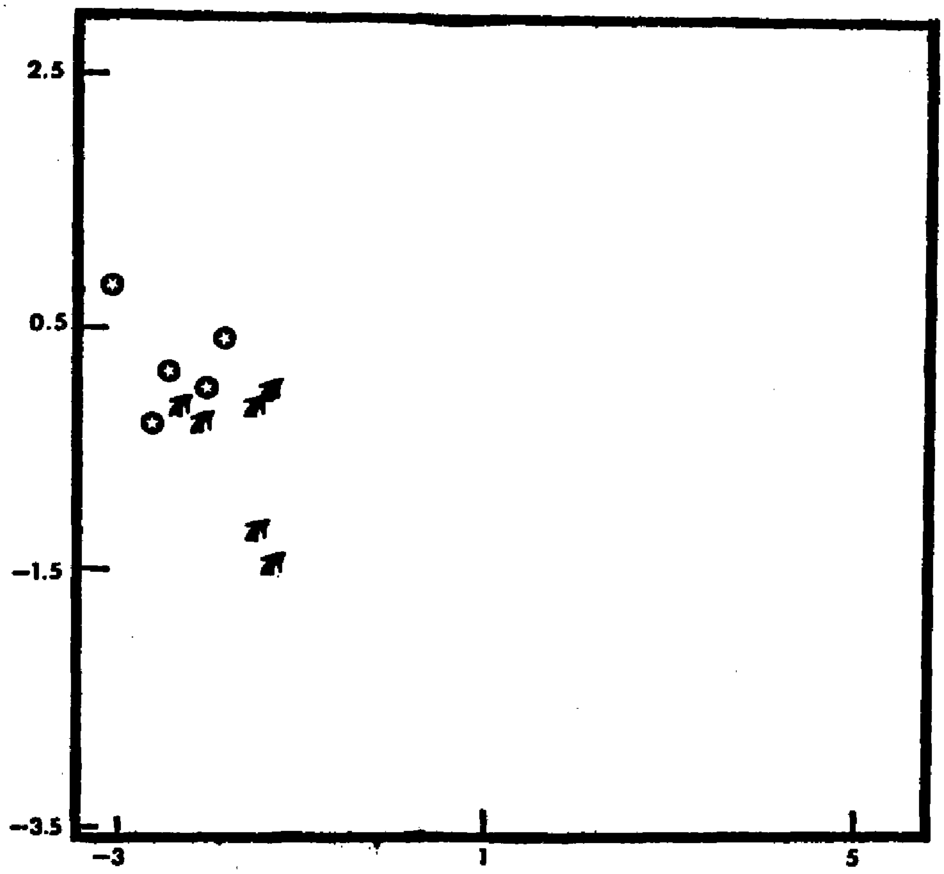

Fig. 26. Comparison of Aluni 6 (circled star) and Aluni 7 (arrow) using Components 1 and 2.

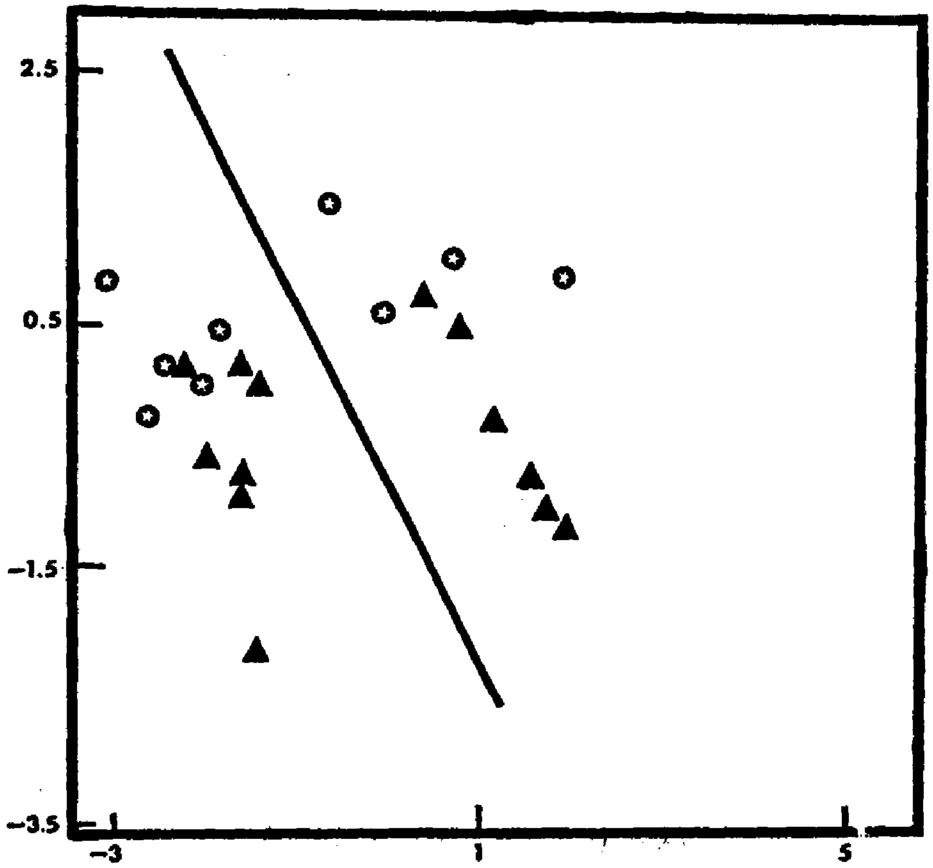

Fig. 27. Comparison of Aluni 6 (circled star) and Aluni 8 (triangle) using Components 1 and 2.

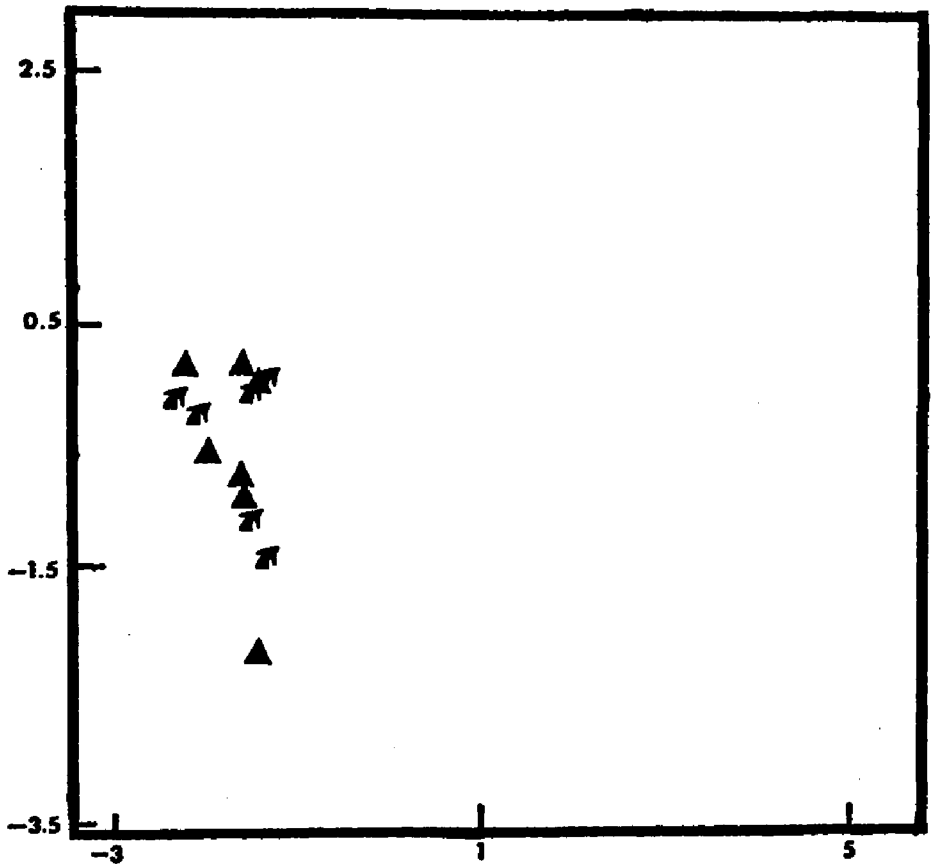

Fig. 28. Comparison of Aluni 7 (arrow) and Aluni 8 (triangle) using Components 1 and 2.

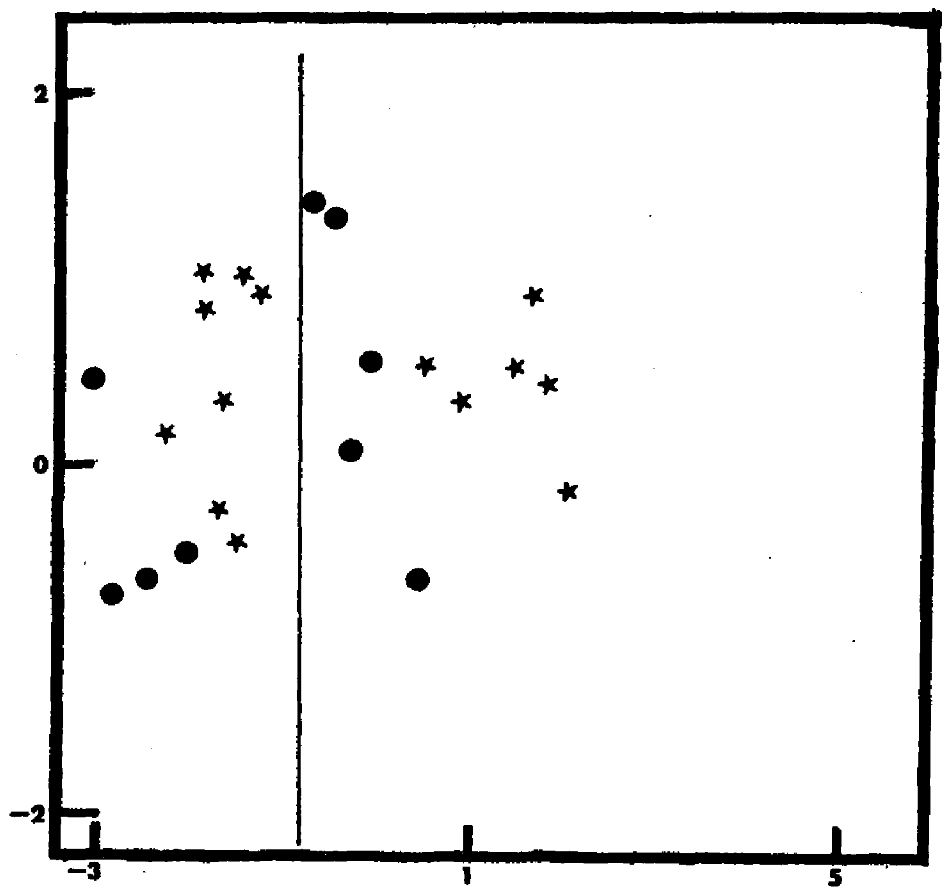

Fig. 29. Comparison of Aluni 1 (closed circle) and Aluni 2 (closed star) using Components 1 and 3.

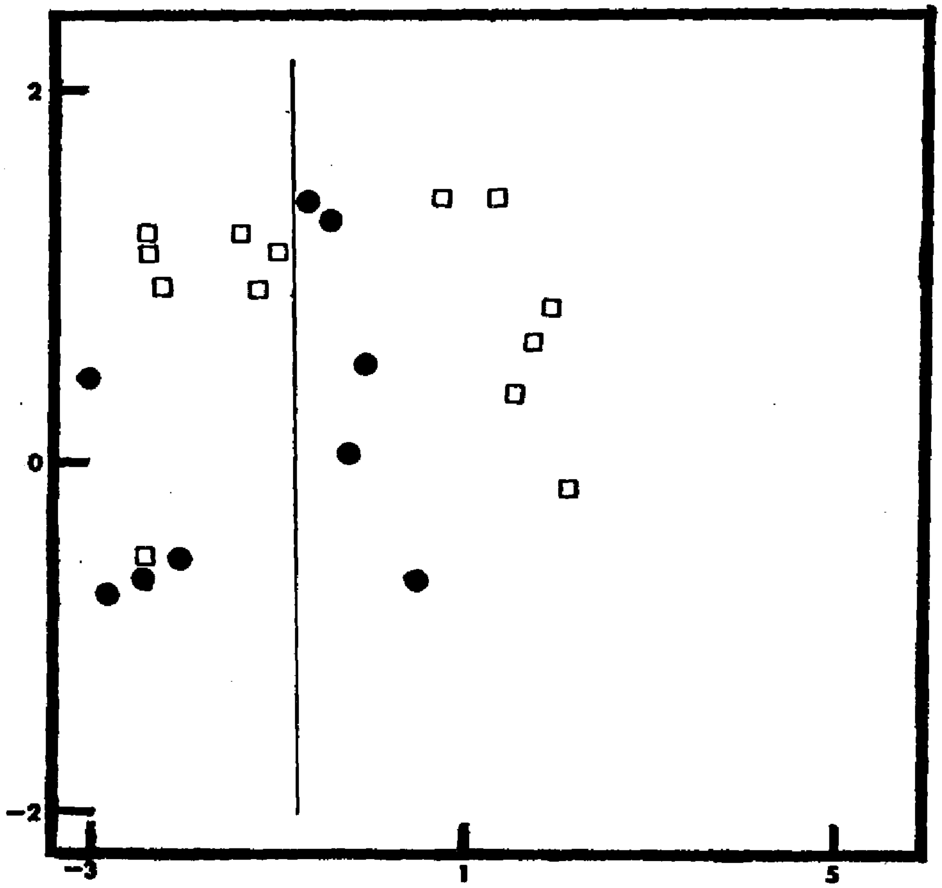

Fig. 30. Comparison of Aluni 1 (closed circle) and Aluni 3 (square) using Components 1 and 3.

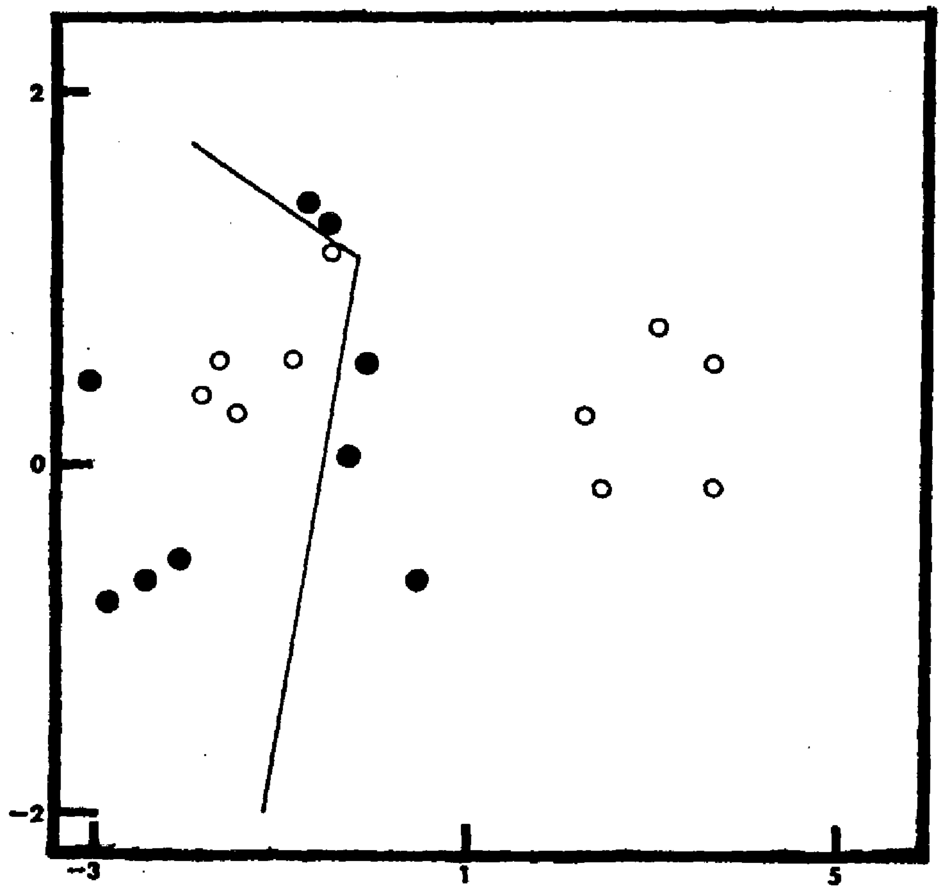

Fig. 31. Comparison of Aluni 1 (closed circle) and Aluni 4 (opened circle) using Components 1 and 3.

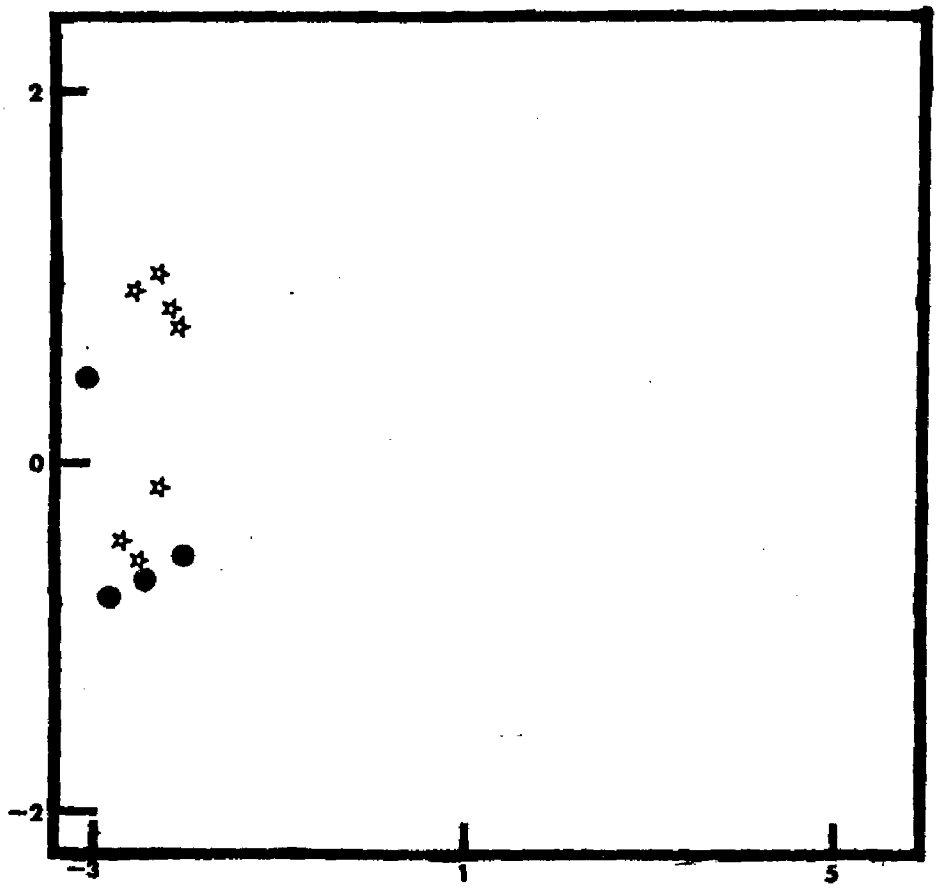

Fig. 32. Comparison of Aluni 1 (closed circle) and Aluni 5 (opened star) using Components 1 and 3.

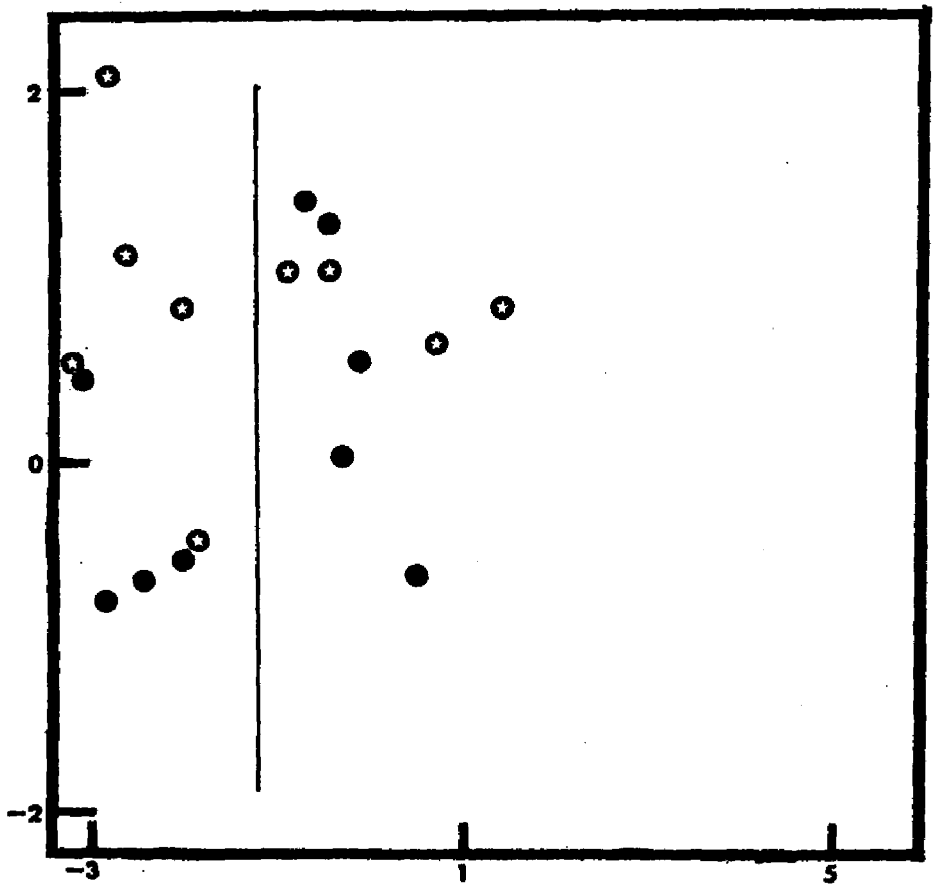

Fig. 33. Comparison of Aluni 1 (closed circle) and Aluni 6 (circled star) using Components 1 and 3.

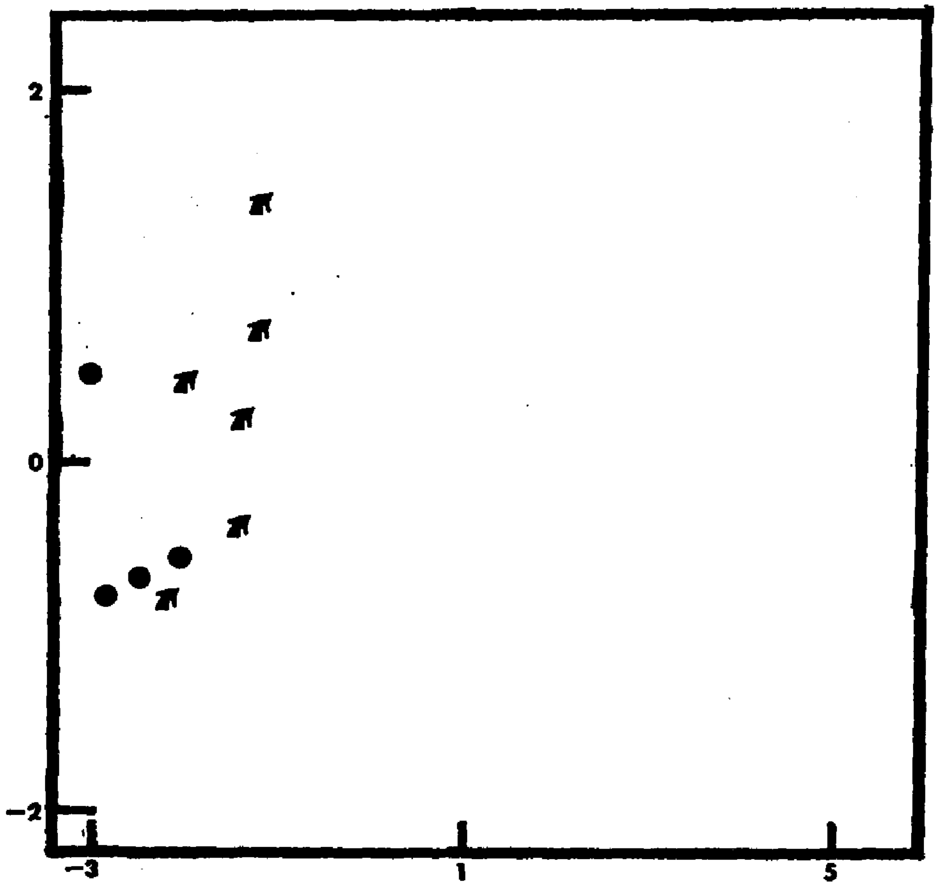

Fig. 34. Comparison of Aluni 1 (closed circle) and Aluni 7 (arrow) using Components 1 and 3.

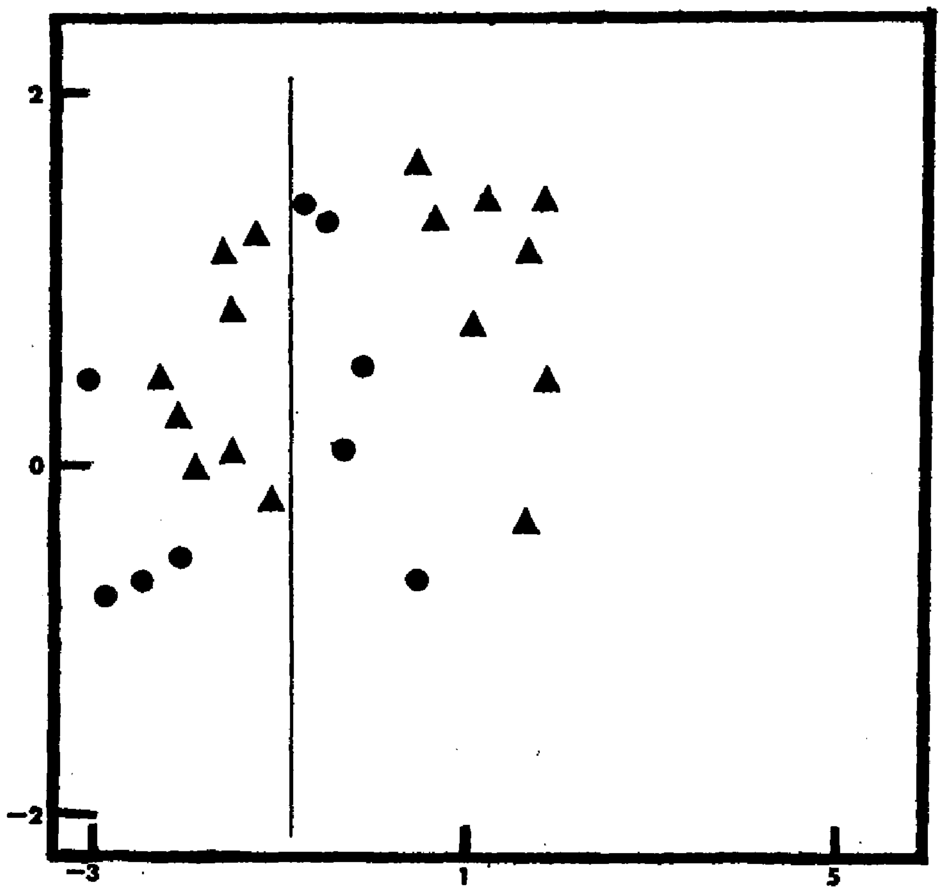

Fig. 35. Comparison of Aluni 1 (closed circle) and Aluni 8 (triangle) using Components 1 and 3.

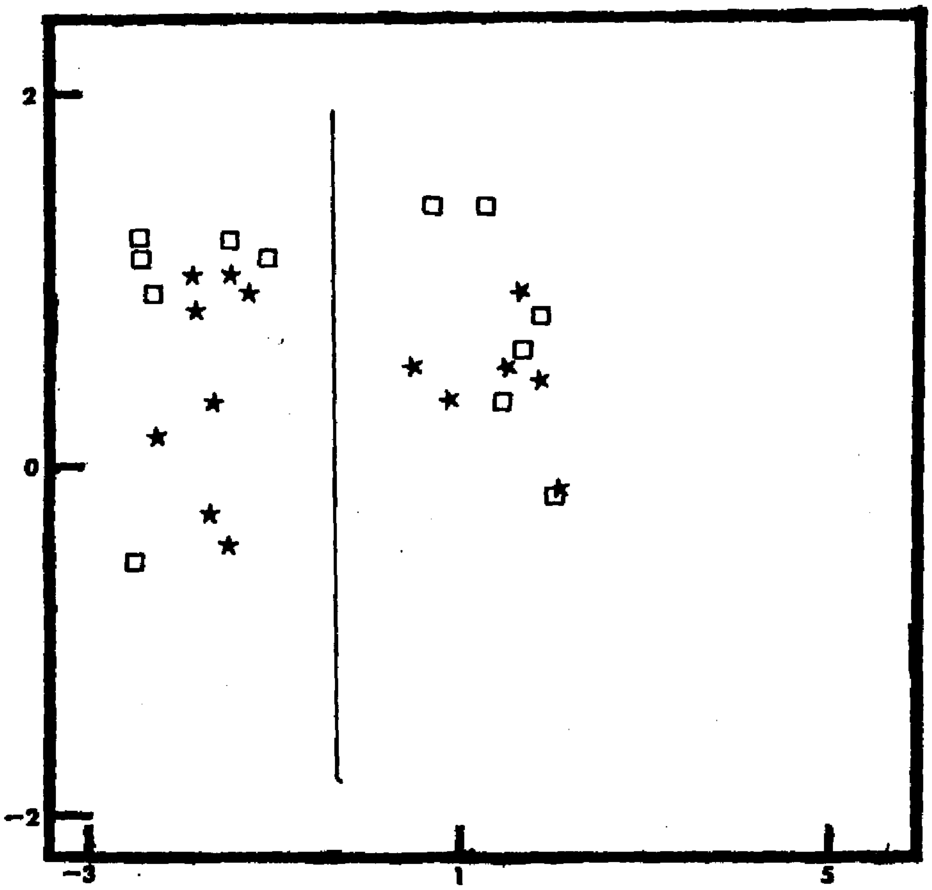

Fig. 36. Comparison of Aluni 2 (closed star) and Aluni 3 (square) using Components 1 and 3.

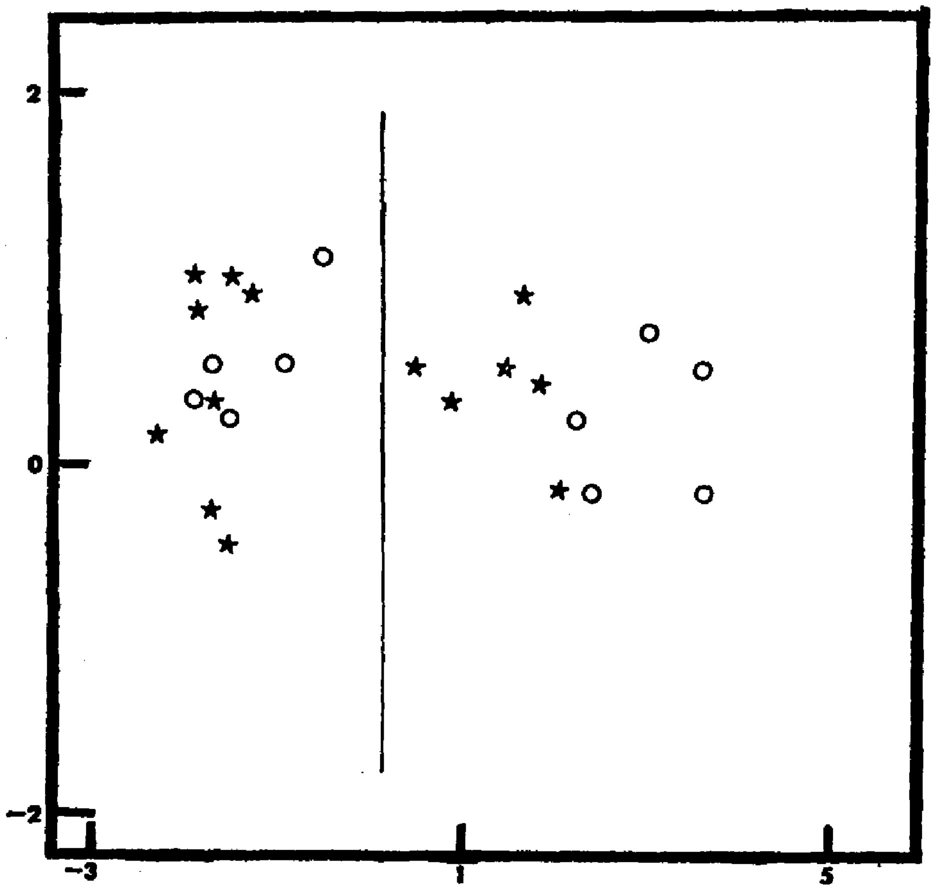

Fig. 37. Comparison of Aluni 2 (closed star) and Aluni 4 (opened circle) using Components 1 and 3.

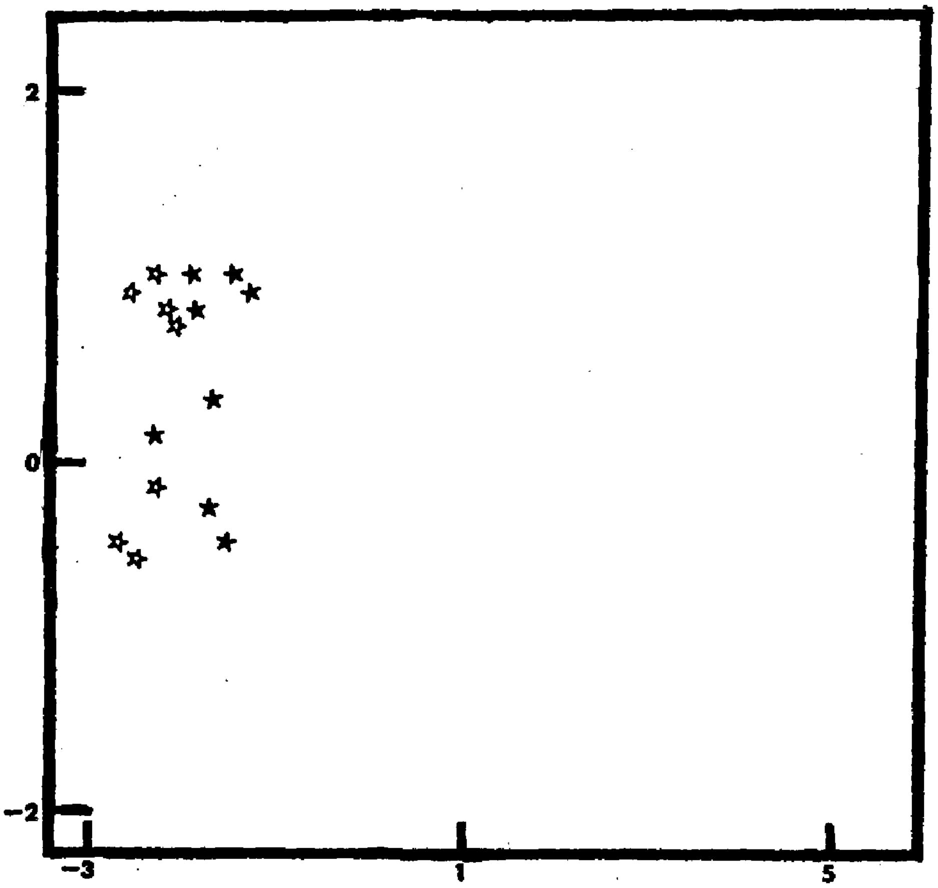

Fig. 38. Comparison of Aluni 2 (closed star) and Aluni 5 (opened star) using Components 1 and 3.

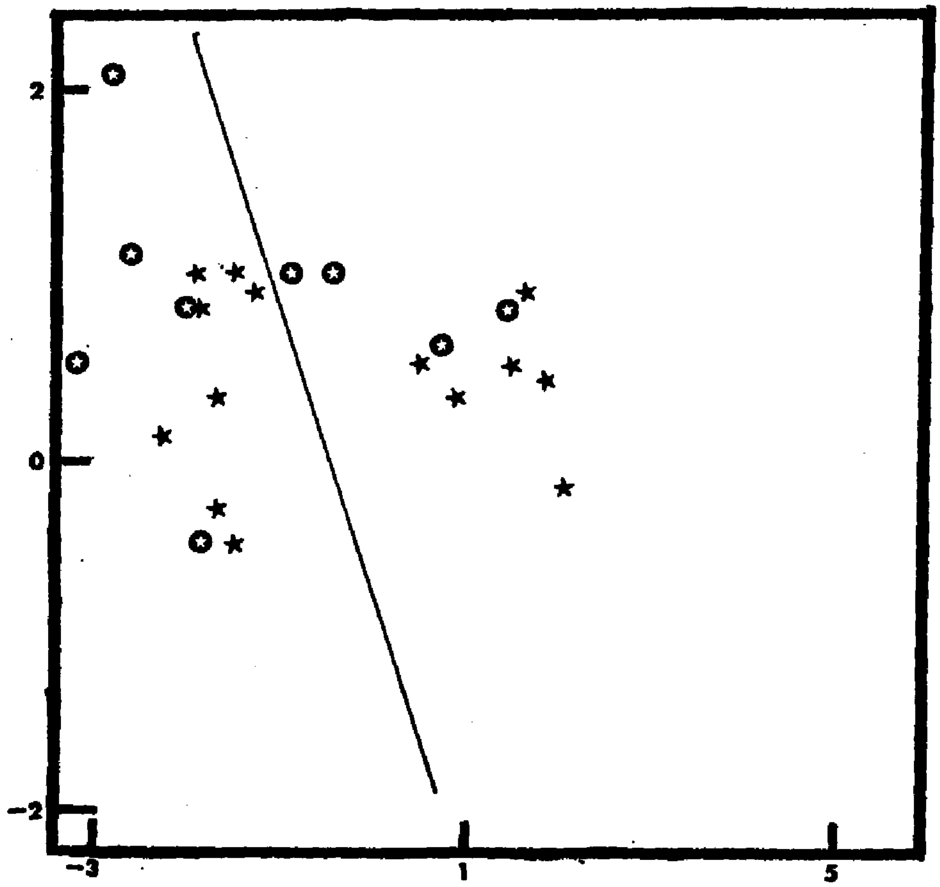

Fig. 39. Comparison of Aluni 2 (closed star) and Aluni 6 (circled star) using Components 1 and 3.

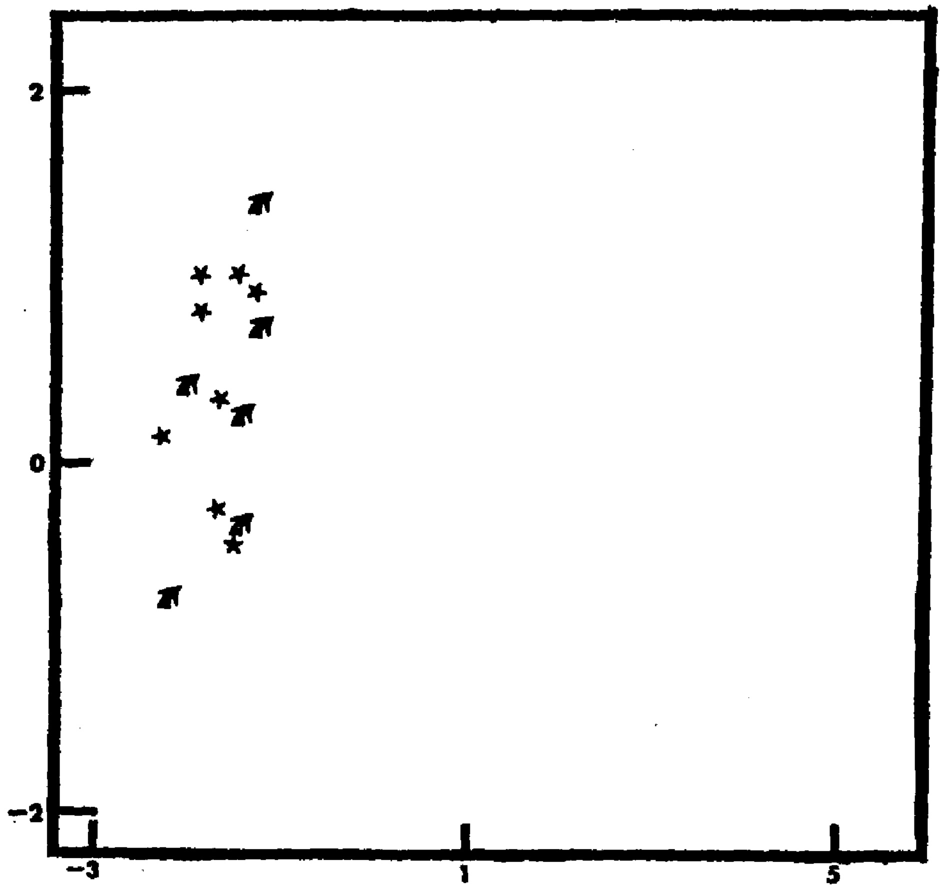

Fig. 40. Comparison of Aluni 2 (closed star) and Aluni 7 (arrow) using Components 1 and 3.

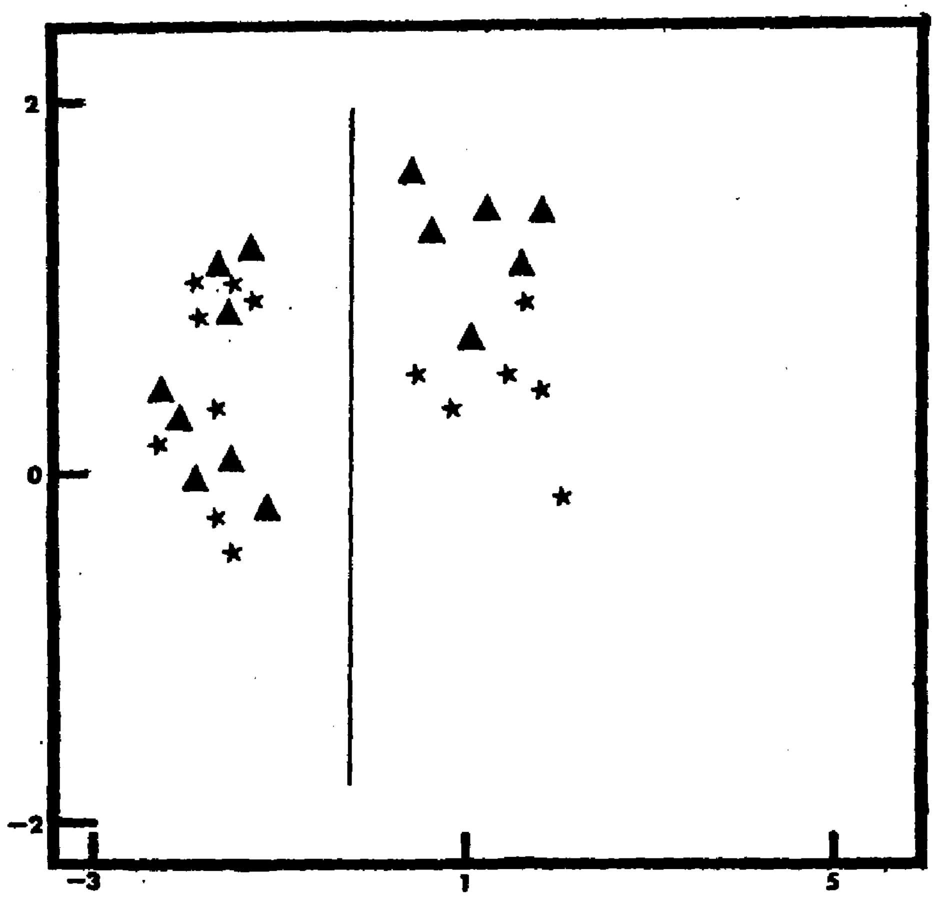

Fig. 41. Comparison of Aluni 2 (closed star) and Aluni 8 (triangle) using Components 1 and 3.

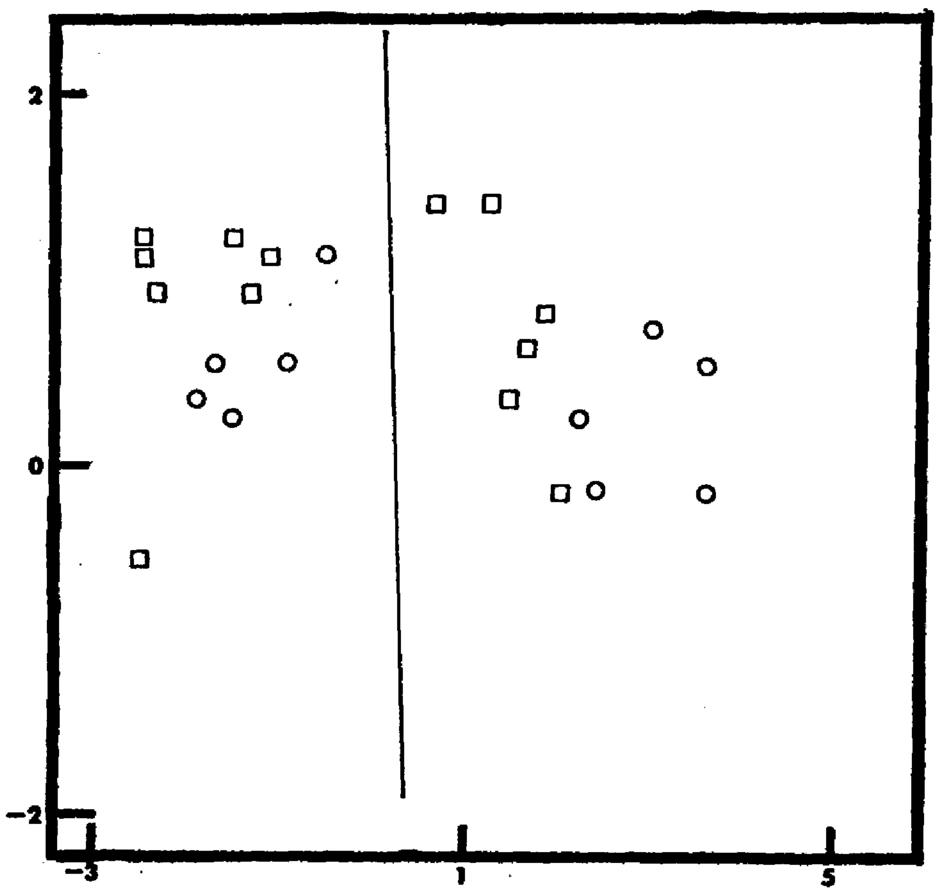

Fig. 42. Comparison of Aluni 3 (square) and Aluni 4 (opened circle) using Components 1 and 3.

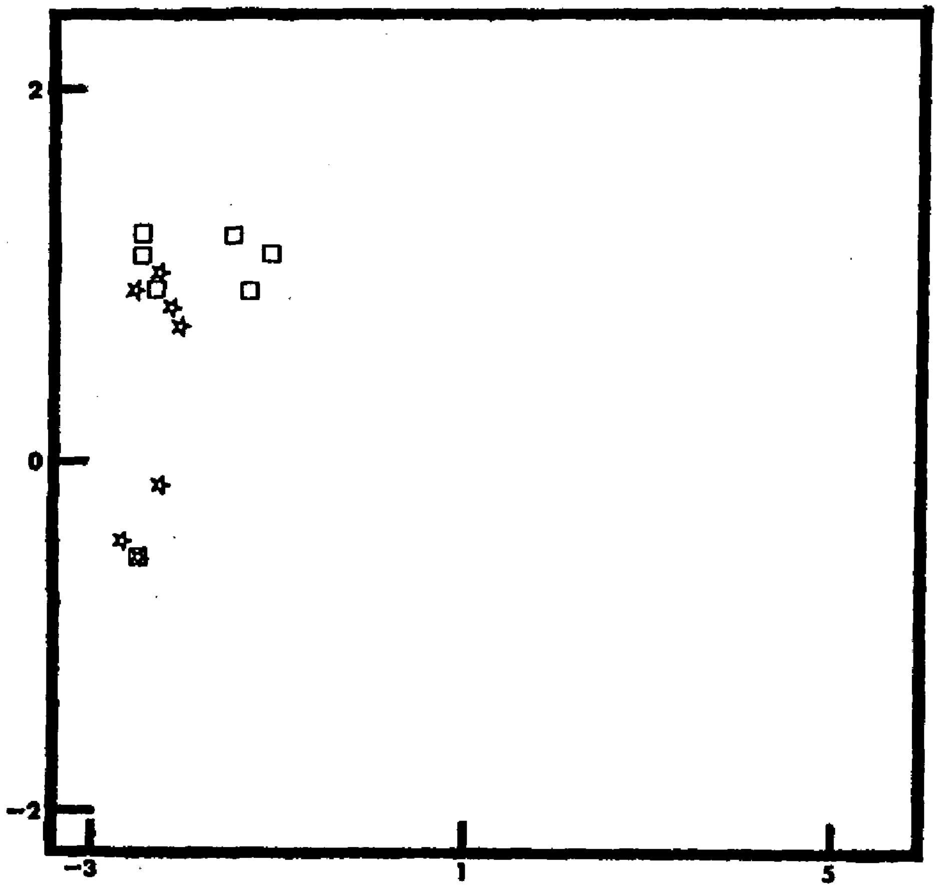

Fig. 43. Comparison of Aluni 3 (square) and Aluni 5 (opened star) using Components 1 and 3.

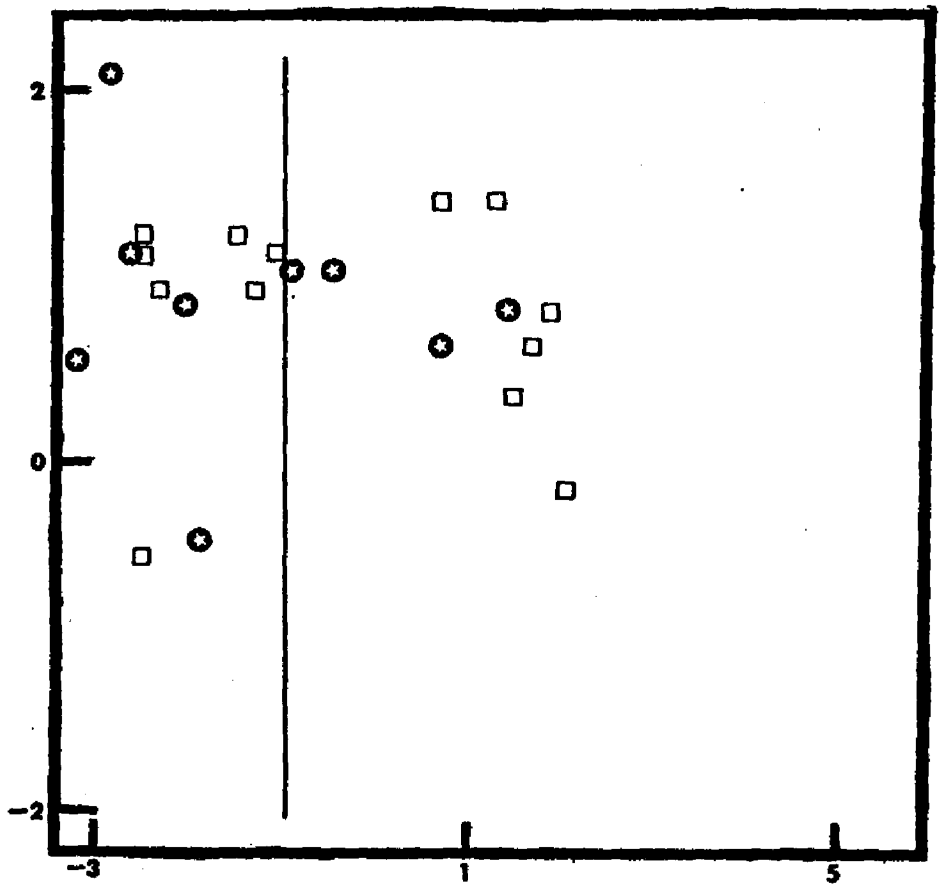

Fig. 44. Comparison of Aluni 3 (square) and Aluni 6 (circled star) using Components 1 and 3.

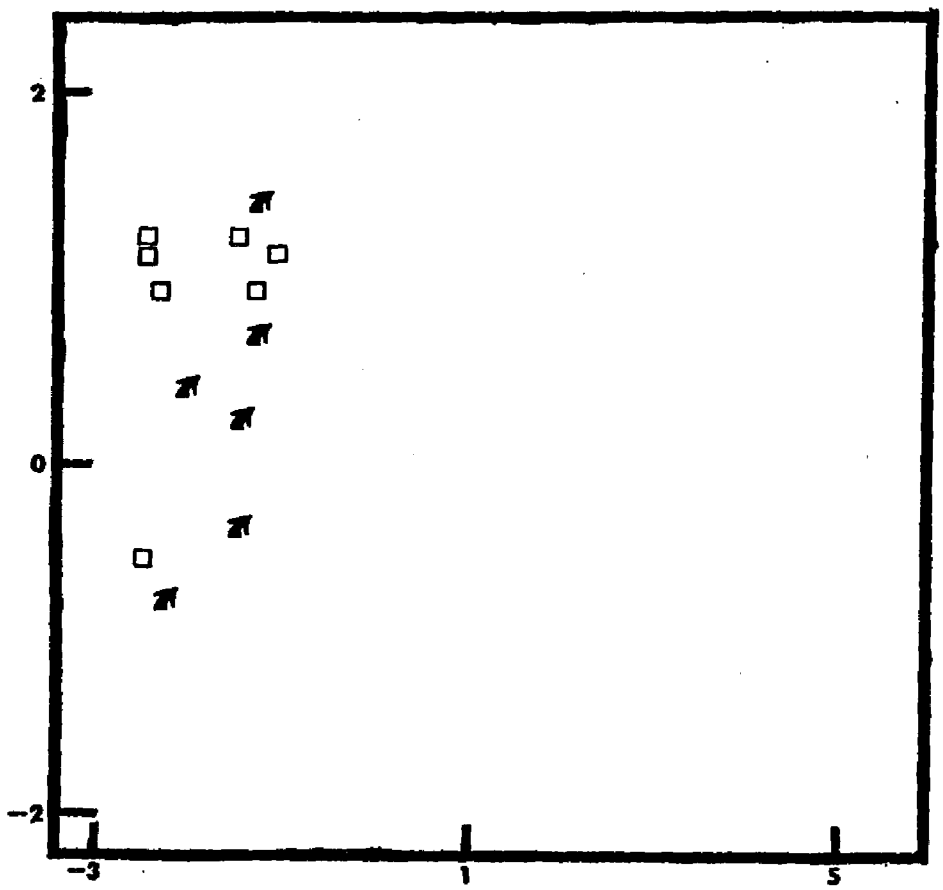

Fig. 45. Comparison of Aluni 3 (square) and Aluni 7 (arrow) using Components 1 and 3.

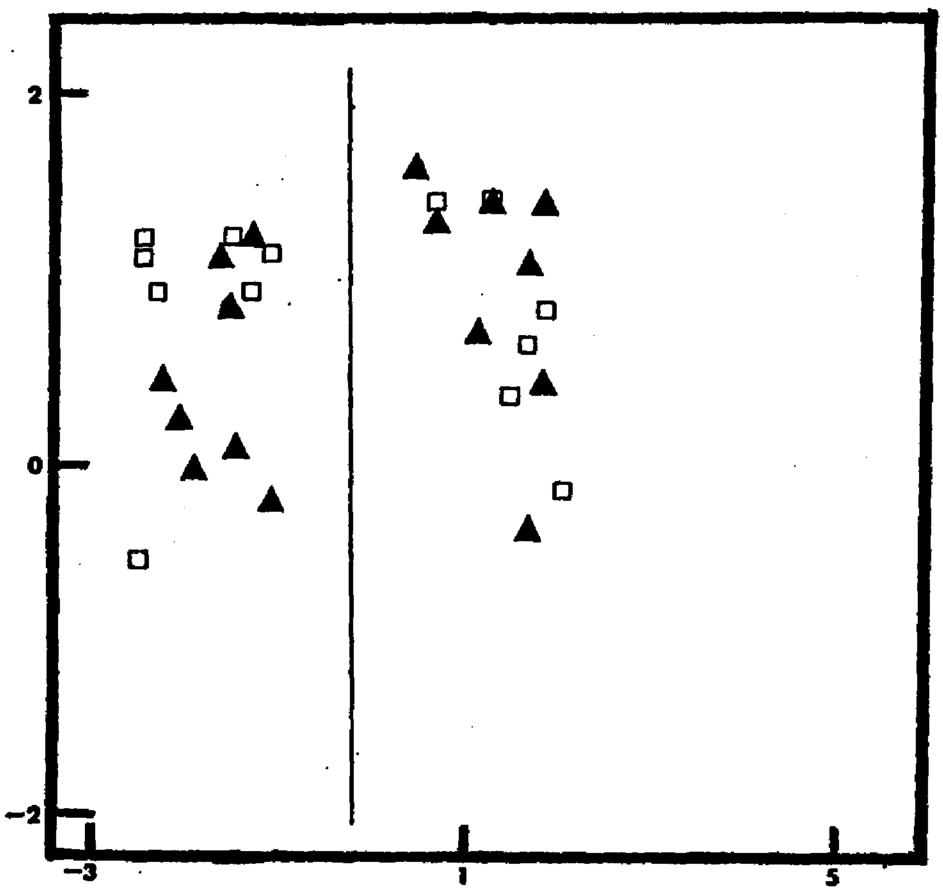

Fig. 46. Comparison of Aluni 3 (square) and Aluni 8 (triangle) using Components 1 and 3.

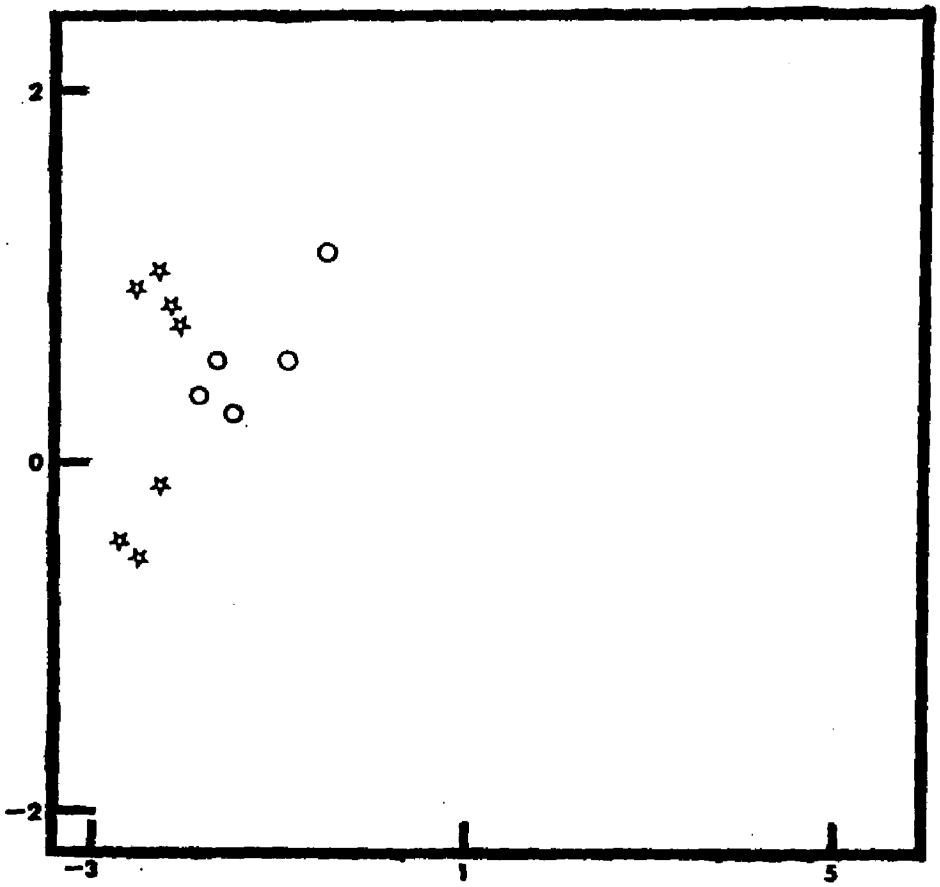

Fig. 47. Comparison of Aluni 4 (opened circle) and Aluni 5 (opened star) using Components 1 and 3.

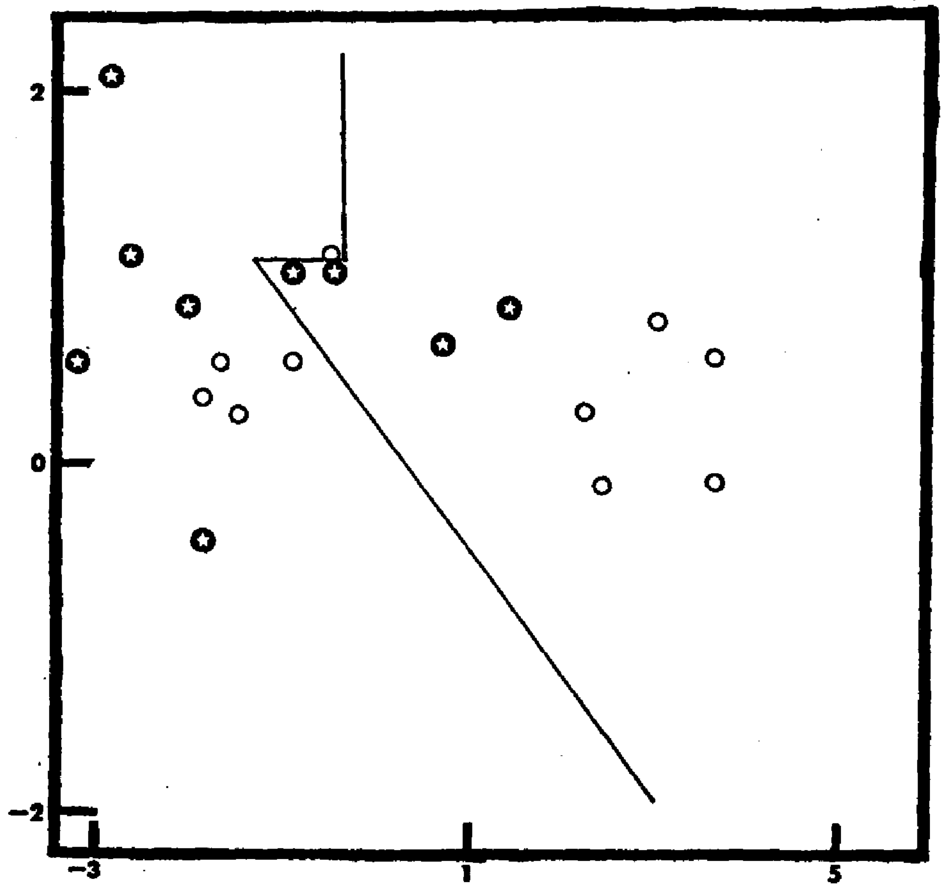

Fig. 48. Comparison of Aluni 4 (opened circle) and Aluni 6 (circled star) using Components 1 and 3.

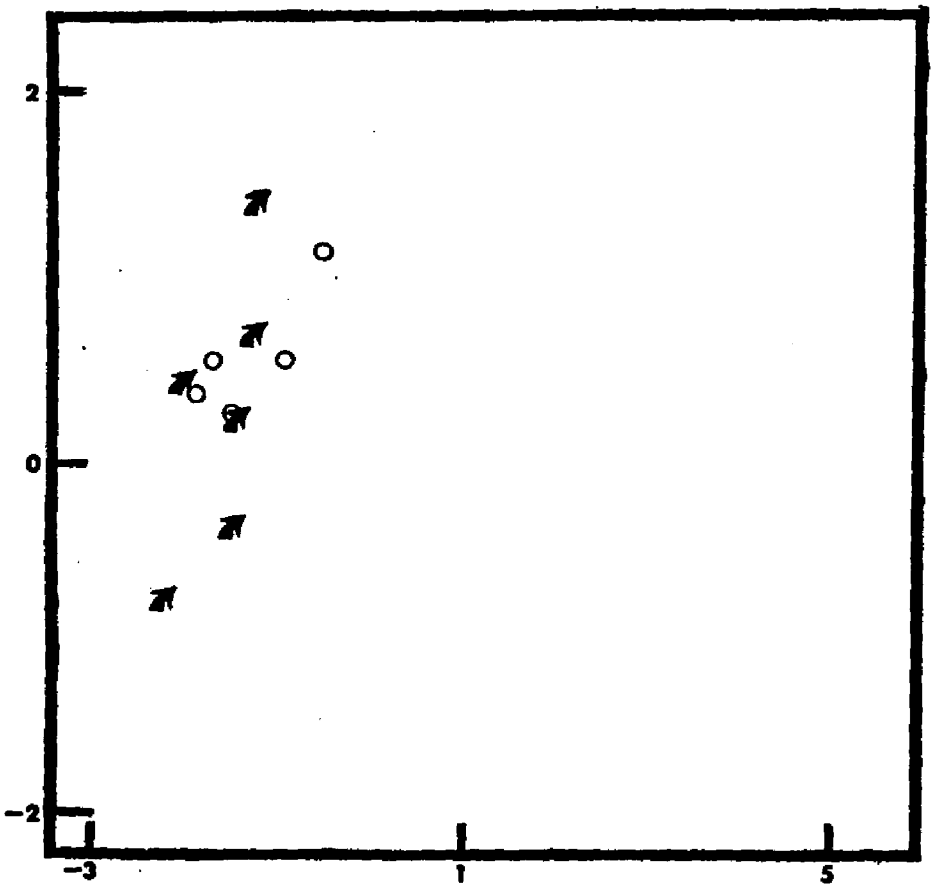

Fig. 49. Comparison of Aluni 4 (opened circle) and Aluni 7 (arrow) using Components 1 and 3.

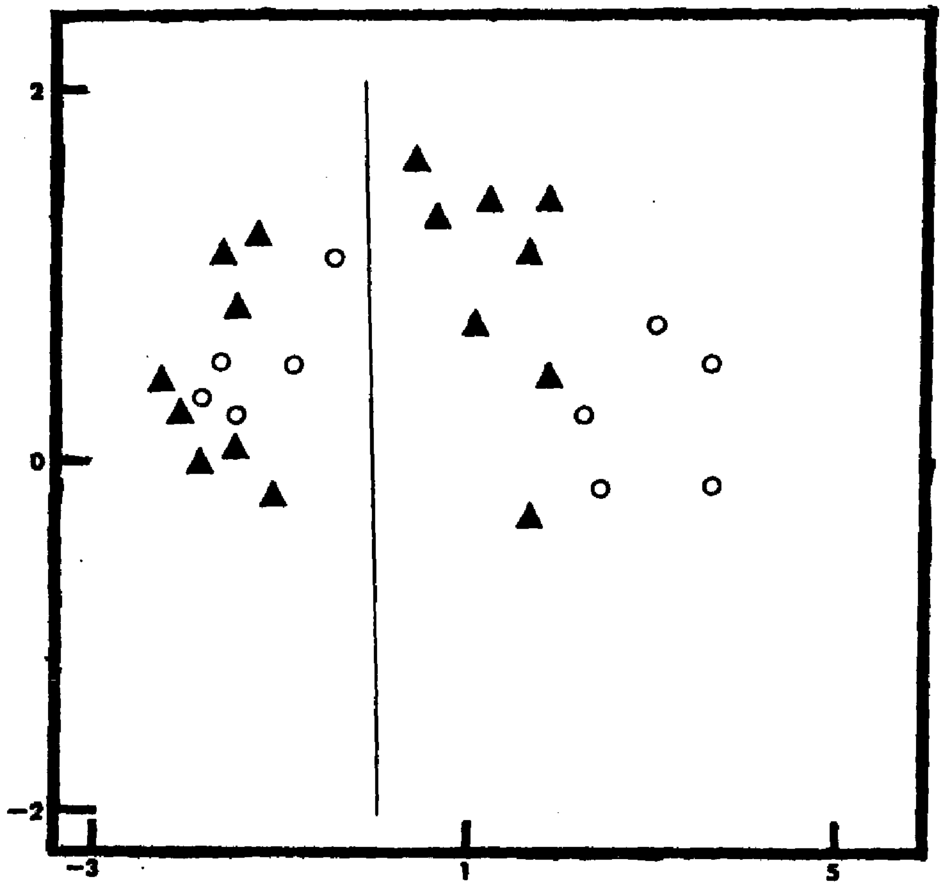

Fig. 50. Comparison of Aluni 4 (opened circle) and Aluni 8 (triangle) using Components 1 and 3.

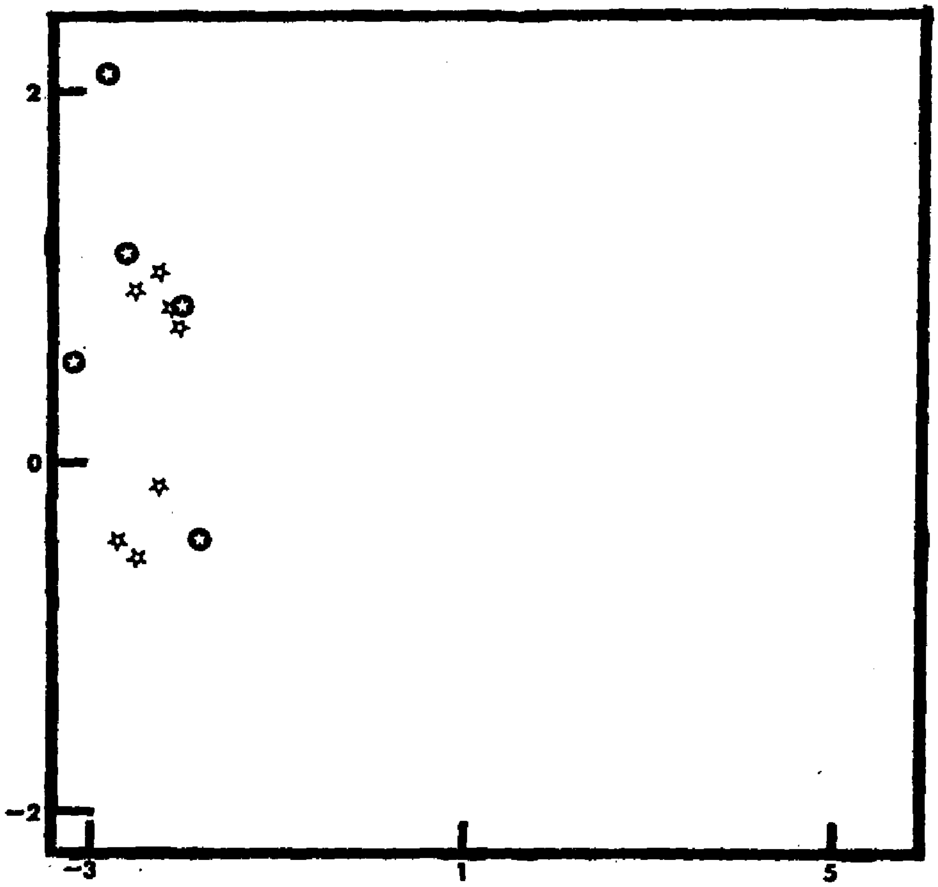

Fig. 51. Comparison of Aluni 5 (opened star) and Aluni 6 (circled star) using Components 1 and 3.

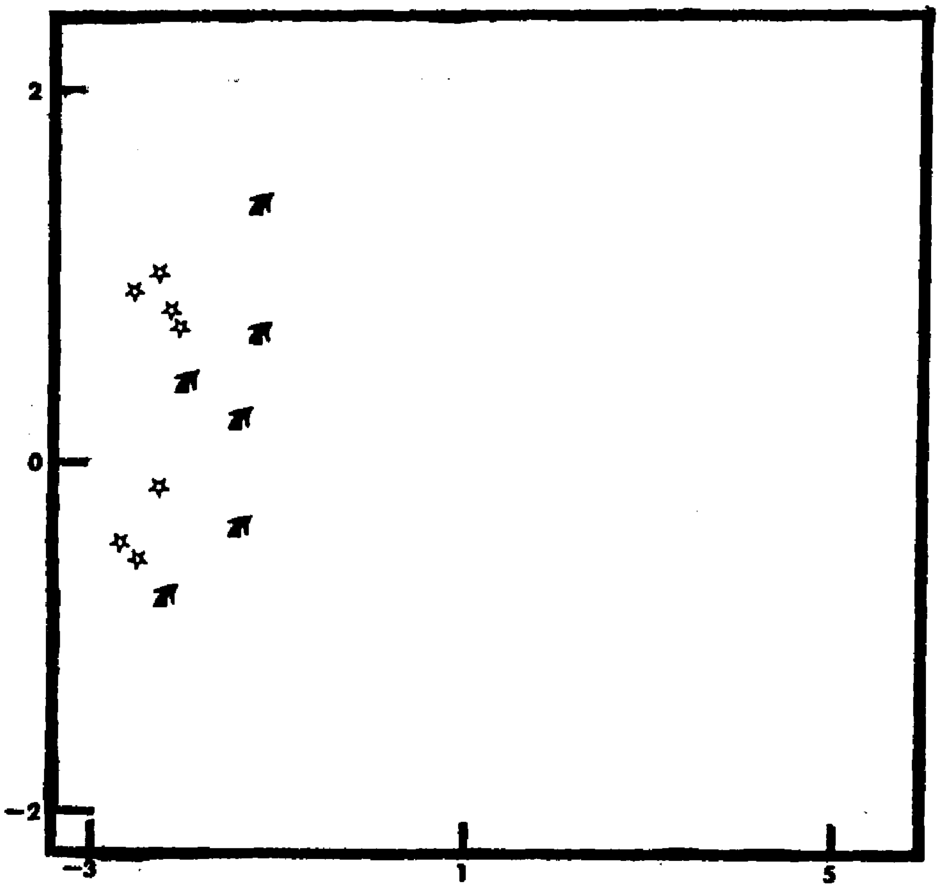

Fig. 52. Comparison of Aluni 5 (opened star) and Aluni 7 (triangle) using Components 1 and 3.

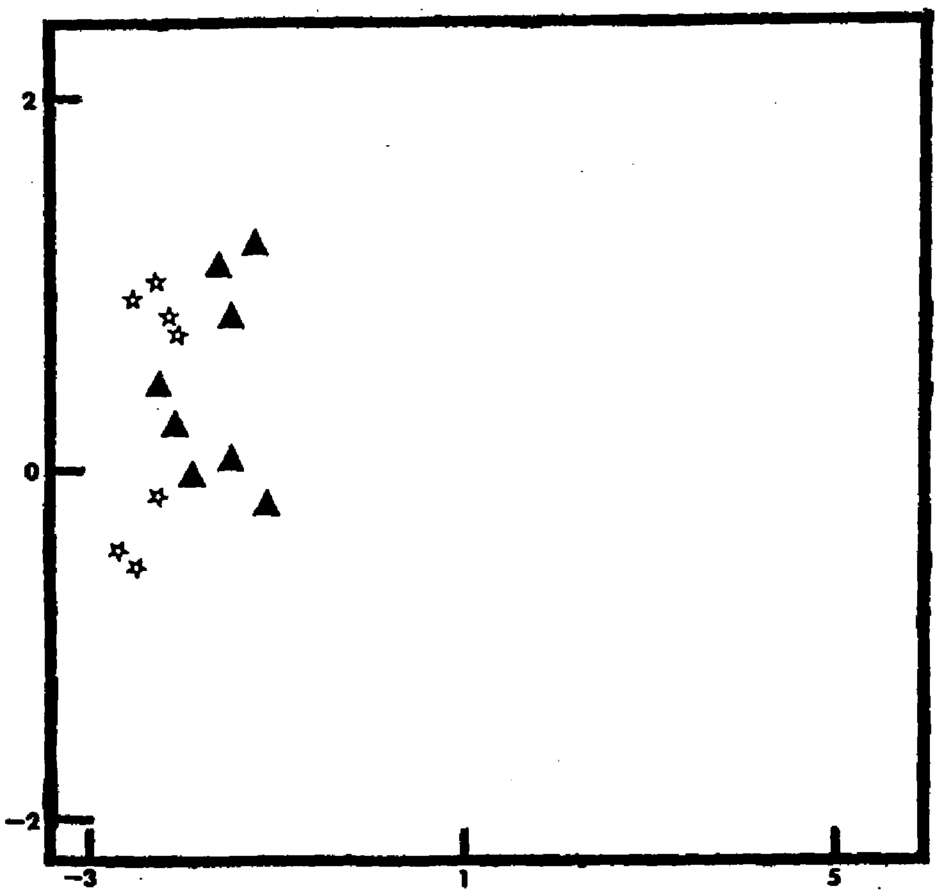

Fig. 53. Comparison of Aluni 5 (opened star) and Aluni 8 (triangle) using Components 1 and 3.

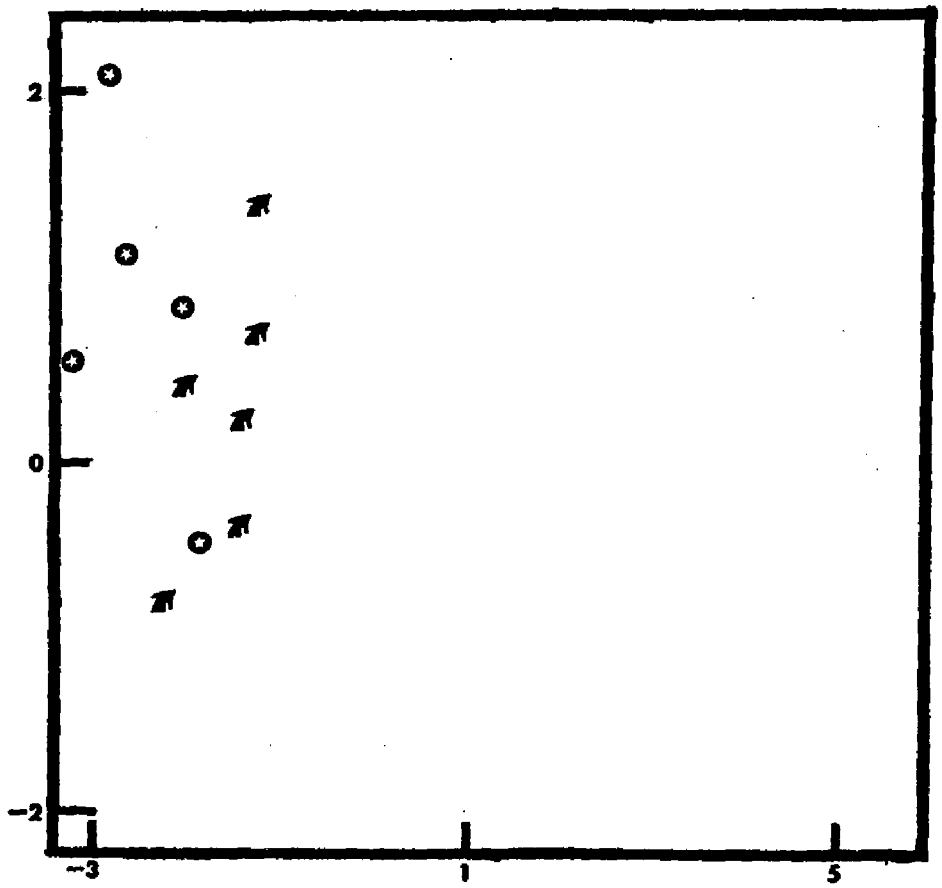

Fig. 54. Comparison of Aluni 6 (circled star) and Aluni 7 (arrow) using Components 1 and 3.

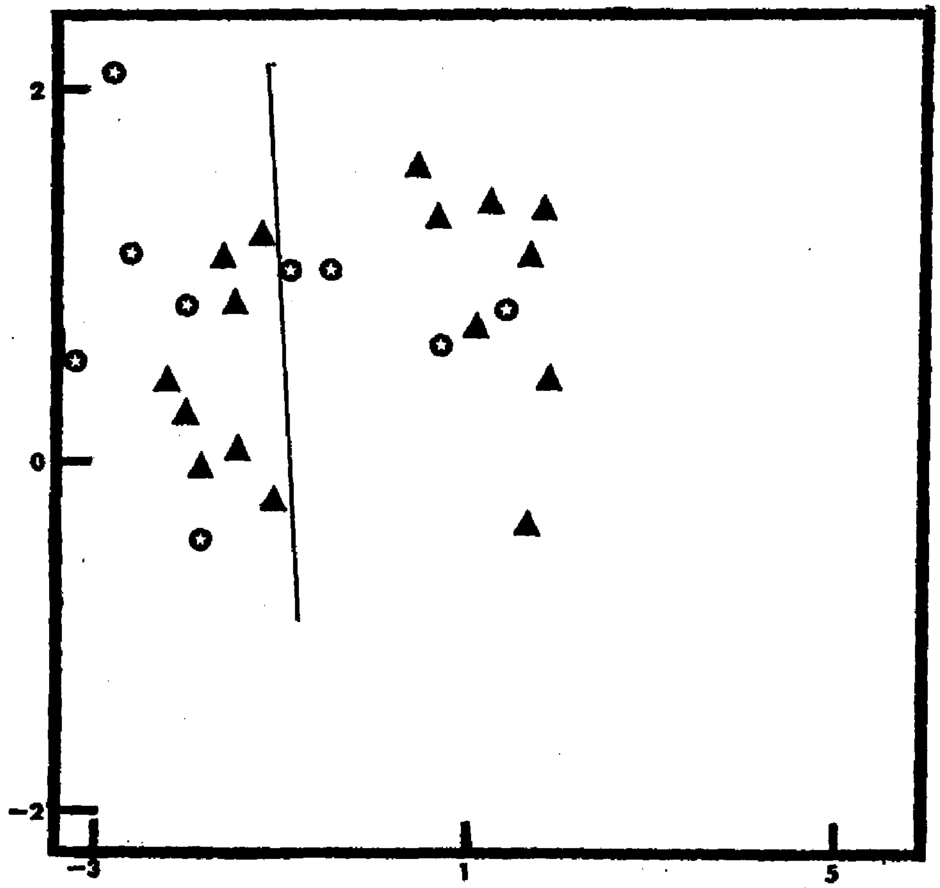

Fig. 55. Comparison of Aluni 6 (circled star) and Aluni 8 (triangle) using Components 1 and 3.

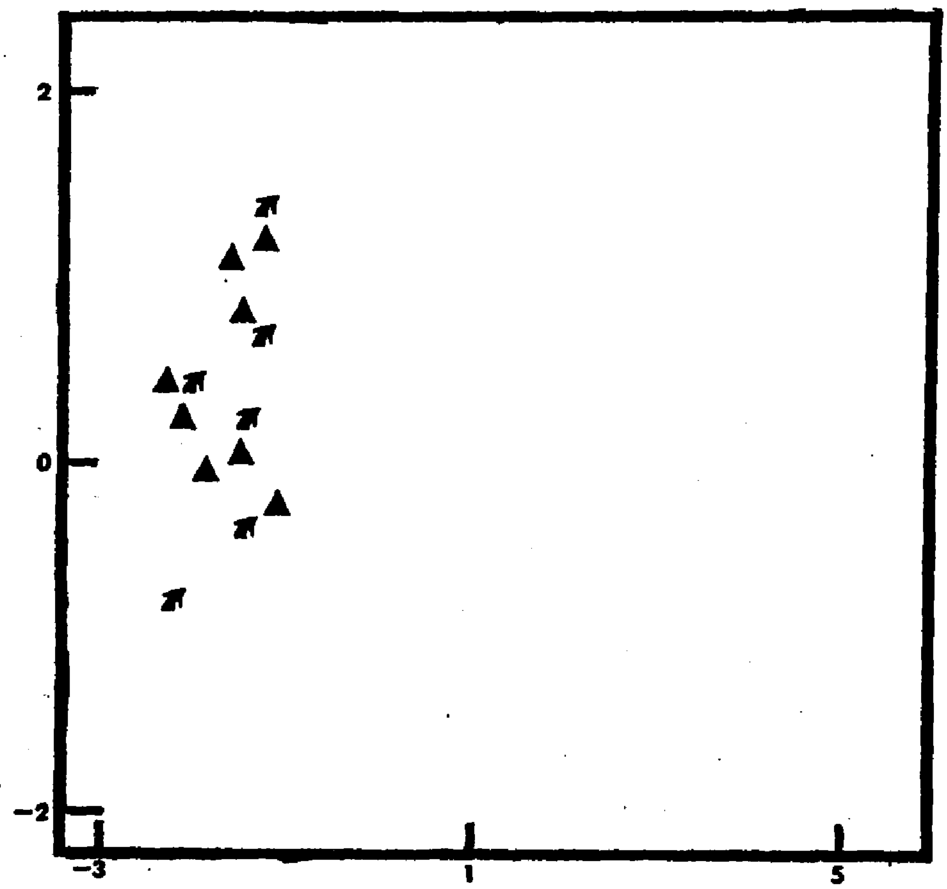

Fig. 56. Comparison of Aluni 7 (arrow) and Aluni 8 (triangle) using Components 1 and 3.

producers. White and Thomas (1972:298) recognized the greater variation in some of the producers as well. They stated: "Persons 2 . . . and 5 . . . are very restrictive as to the sizes of their tools, but allow a considerable range of angles and length-breadth ratios." From my analysis, it appears that Aluni 2, 4, 7 and 8 were the least distinctive in their selection of are´ kou. Of the 15 comparisons which failed to discriminate between individual producers of are´ kou, 12 of these failures involved these knappers. The overall pattern of these knappers, however, was distinctive as they were distinguishable in 80.0% or more of their comparisons (24 of 30). Aluni 5 could not be distinguished in only two of his comparisons for are´ kou. Aluni 5 may have had considerable range for these components but he was still quite distinct. This finding enhances the conclusions of White and Thomas, as they suggested that Aluni 5 was quite variable. The two unsuccessful comparisons of are´ involved Aluni 3 with either Aluni 2 or 8. These two tests do not detract from the overall distinctness of Aluni 3, as he was distinguishable in 80.0% (8 of 10) of his comparisons. It was impossible to assess the degree of distinctiveness of Aluni 5 for are´ TMDs because he was removed from this part of the analysis.

An analysis of table 2 also shows that Aluni 5 and 6 appear to be most distinctive. Every comparison of are´ and are´ kou involving Aluni 1 showed distinctiveness, whereas Aluni 5 failed to discriminate in only two comparisons. Therefore, the analysis of the data through the use of pairwise comparisons has provided an understanding of the degree of individual variation and distinctiveness which complements the method of analysis used by White and Thomas. Their analysis is suitable for describing the ranges of variation permitted by each knapper in the selection of tools. Thus, they were capable of stating that certain individuals had a "considerable range of angles and width."

This refinement of the data and conclusions provided by White and Thomas can easily be translated into an archaeological situation if one assumption is made, i.e. once the artifacts are manufactured, they tend to be discarded only in the producer's activity area or unit of comparison. Numerous factors such as post-marital residence pattern, borrowing, payment of debts, exchange, etc., might cause goods to be moved from one activity area to another and ultimately distort the true pattern. Therefore, artifacts whose life spans are short, such as the bowl forms considered in the real archaeological situation at Divostin, seem most appropriate. By virtue of their short life spans, the bowls are less affected by the factors enumerated above. The bowls would be most likely found in their proper area of use.

If the TMDs that are produced by each man can be attributed, as artifacts, to the floors of their respective residential units, then pairwise comparisons of these residential units can be conducted for the same distinctness described above. These activity areas represent one of many possible units of comparison. Using the results of the comparisons discussed above, it would then be possible to conclude that individual production was associated with most residential units within the village. That is, craft specialization in the manufacture of stone tools was absent. This constructed situation is similar to the potential archaeological reality since many of the tools that each person manufactures are brought back to their respective houses for storage prior to their next use.

The lack of distinction between some of the houses might present some problems in interpretation. It could be inferred from the lack of distinctiveness in some comparisons that craft specialization was present, though in a limited form. This conclusion, however, can be faulted on two grounds. First, the overall village pattern is clearly household production. Second and more importantly, if these tools were coming from one of the other producers in the village, then non-distinctiveness should be seen with only those people (houses) who in fact manufactured the tools. The lack of distinctiveness of Aluni 2, 4, 7 and 8, particularly among themselves, when compared with their distinctiveness with respect to other knappers in the village, can more reasonably be argued as instances of producers with broad ranges of variation in the material goods they manufacture, resulting in occasional overlapping of their products.

This constructed archaeological situation demonstrates that inferences can be made about systems of production utilizing the concepts of idiosyncratic variation and distinctness. However, the inferences about systems of production are based on the comparison of materials associated with a set of features located at the site. Materials from features must be compared because of the difficulty in determining which person made the artifacts found at the site. Thus, the yields of features are compared for their distinctiveness or non-distinctiveness. A set of distinctive features permits inferences that the system of production was household or non-specialized. A set of non-distinctive features permits the inference to be drawn that the system of production was specialized. However, this is only one of several possible explanations which would be consistent with a set of non-distinctive features. Household exchange and multiple producers are two alternative hypotheses. Control of these and other variables can be accomplished as seen in chapter II, below, and chapter IV.

Conditions for Testing Systems of Production

Inferences relating idiosyncratic patterning to systems of production can be carried out if there are contexts within a site that allow one to hypothesize the existence of individual craftsmen. This can best be accomplished if the compared contexts are equivalent.

The sources of variability in material culture are many and include patterns of production. It is important, however, to control as many of these variables as possible before differences in one type of artifact at one site can be related to systems of production, either household or specialized. Important sources of variability aside from idiosyncratic factors include the function of the context in which the artifact is found, status differences between compared contexts, differences in ethnicity between units of comparison, and chronological differences between units of comparison or the artifacts themselves. While this list is not in any way exhaustive, control of these sources of variability will permit reasonable inferences utilizing the notion of systems of production as a means of explaining the existing patterns of variation in one artifact type between compared contexts.

These conditions of equivalence are more frequently met than might be initially assumed. A partial listing of archaeological situations amenable to testing for systems of production would include room to room comparisons in pueblo sites in the southwestern United States, fire hearth to fire hearth comparisons in Upper Paleolithic sites in Czechoslovakia, and house to house comparisons in Late Neolithic sites in Jugoslavia as situations where equivalent and synchronous activity areas are found.

The equivalence of activity areas or contexts is essential for the success of the analysis. Though the analysis uses the artifacts within each of these contexts, it is the contexts that are ultimately being compared. The artifacts to be tested within each of these activity areas should reflect similar contextual relationships. If the contexts for the artifacts are similar, then it can reasonably be argued that the functions of an artifact type within these contexts are similar. Therefore variation within an artifact type across these contexts can be attributed to factors other than function such as systems of production and/or exchange.

Similar assumptions of equivalence have been made by Longacre (1968) and Whallon (1968) to cite just two examples. In the first of these studies, Longacre assumed similarity in function for each of part of the pueblo; Whallon assumed similarity in function for each of several different villages. In both cases, ceramics were analyzed for differences between similar activity areas. Therefore differences which did emerge in the analysis could be attributed to factors other than function, e.g. in those instances, social organization. If equivalence cannot be demonstrated for each of the units used in the comparisons, the conclusions from each of these analyses would then be subject to reevaluation.

People from different ethnic backgrounds will undoubtedly have somewhat unique sets of artifacts, though the artifacts may seem on the surface to be similar. White and Thomas (1972) reported that two villages, Aluni and Hareke, belonging to the same ethnic background, could be distinguished by an examination of the distribution of their TMDs. Thus, it appears that face to face contact may also be a significant factor in the determination of "the proper form of an object." Whether or not this contact is sufficient to overcome ethnic or village differences is uncertain. The consideration of varying ethnicity as a contributing factor to the variability within an artifact assemblage should be viewed from the possible models of production: household or specialized.

In systems of specialized artifact production, ethnicity becomes a significant factor when it is assumed that the consumer will select from the "market" or have artifacts produced which reflect their different backgrounds. These conditions seem less than likely. The differences between objects belonging to the same type seem so small so as to preclude the possibility of a specialist manufacturing the artifacts for each unit of comparison to fit the customer's request. The distribution of artifacts along the dimension used in the analysis shows considerable overlap. Distinctness becomes more apparent as comparisons are made which utilize two or more variables simultaneously. When systems of production are household based, differing patterns of ethnicity can only enhance the distinctness which is already present.

Status differences can also account for some of the variation within an artifact type. Within a settlement, it is quite possible to have units of comparison, e.g. houses, occupied by people of different status. Each status level may require the production of goods slightly different than any other status level. Thus, the artifacts within the houses may reflect these status differences and not necessarily the system of production. This variable, though a contributing factor to the total variation of a single artifact type at a site, only becomes significant when each house is distinct and the assumption is made that a specialist(s) produced goods to reflect the difference in status held by the occupants of each house. This seems an unlikely possibility within a single artifact type where differences among members of that type are minor.

It can reasonably be argued that one or two houses within a settlement may contain somewhat different items within an artifact type because the status of the occupants is unique. This can enhance a pattern of household production in which all other houses are distinct and mask the possibility of some specialization within the village if these unique houses did not produce their own goods. On the other hand, if all other houses are non-distinct indicating specialization, the distinctness of one or two houses can possibly be explained through difference in status. This would not indicate who produced the artifacts for the distinct houses, either an outside specialist or an occupant of the house itself. Additionally, the variability in artifacts within a single type are so small as to all but eliminate the possibility of a specialist who produces artifacts to reflect the different status positions of each activity area. In summary, then, status differences unquestionably contribute to the variation within an artifact type. It is highly unlikely for status differences, however, to entirely distort a system of artifact production.

It is also important to establish synchronism among the activity areas that are being evaluated for idiosyncratic patterning. This synchronism reduces the possibility of temporal variation. If both equivalence and synchronism of activity areas is established, then the differences within one artifact type found within these features is reduced to non-functional and non-temporal factors like idiosyncratic variation within these larger units can then be used to allow inferences about systems of production.

Two other general comments are now appropriate. First, Divostin, the prehistoric site considered in chapter 4, does not show any evidence for people of diverse ethnic backrounds or status positions. The evidence provided in that chapter suggests a homogeneous ethnic group with little or no status differentiation evident in the excavated artifacts. Second, ethnicity and status differences, when present, should separate units of comparisons into a number of clusters considerably smaller than the units of comparison used in the analysis. As an example, Longacre (1968) was able to suggest two general residence units in his study of the Carter Ranch site. The general patterns of artifact production, household or specialized, should appear despite these variables. Thus, ethnicity and status, while possible factors, should not influence the Divostin tests.

Production and Distribution Models and Degree of Product Uniformity

Various production/consumption models can be defined which explain the variability (either distinct or non-distinct) among units of comparison. One way to generate these models is to vary the number of outside sources from which the people within a settlement can obtain their artifacts. There is of course a continuum for the number of outside sources ranging from the many producers available in a market economy to the absence of outside sources found in household production systems. For purposes of presentation this continuum is divided into three categories: A) unrestricted number of outside sources, B) restricted number of outside sources, and C) no outside sources. The specific production/consumption models within each of these categories are listed below and discussed with reference to variability among the units of comparison (see figure 57 for a schematic representation of each model).

A) Unrestricted number of outside sources

1. Market
2. Trading partners

B) Restricted number of outside sources

3. Distributor
4. Itinerant specialist

C) No outside sources

5. Village specialist
6. Household production

Three of the six proposed models (numbers 3, 4, and 5) can lead to high similarity (non-distinctness) among units of comparison and the inference of craft specialization. Thus the inference would be correct in these cases. Model 3 has the goods of one or more specialists (but still quite limited in number) coming into the village through a middleman. The middleman can be either a villager or someone outside the settlement. In either case, however, the middleman pools the artifacts of the various producers prior to their distribution within the village.

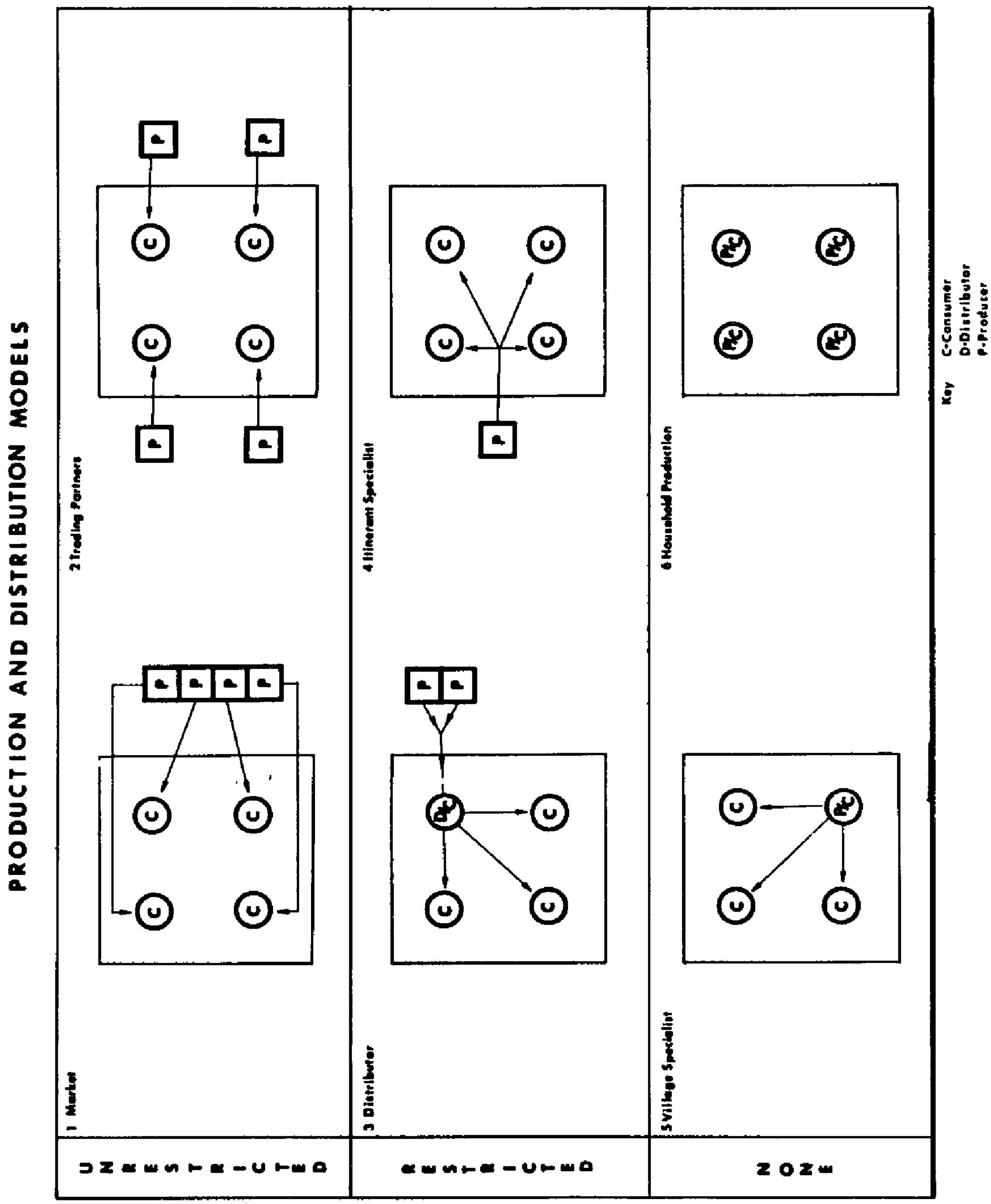
PRODUCTION AND DISTRIBUTION MODELS
UNRESTRICTED
RESTRICTED
NONE
1 Market
2 Trading Partners
3 Distributor
4 Itinerant Specialist
5 Village Specialist
6 Household Production
Key
C-Consumer
D-Distributor
P-Producer

Fig. 57.

Thus high similarity among units of comparison would result. Sahlins (1972:286-288) has described this most familiar pattern of exchange and distribution for the Huon Gulf of New Guineas in the following manner:

> Local specialization in craft and food production within the system is attributed by Hogbin to natural variations in resource distribution. A single village or small group of adjacent villages has its characteristic specialty. Since voyaging ranges are limited, centrally situated communities act as middlemen in the transmission of specialized goods produced towards the extremities of the Gulf. The Busama for instance, from whose vantage the trade was studied, send southward the mats, bowls, and other goods manufactured on the north coast, and send northward the pots made in the southern villages.

Model 4 has the outside specialist entering the village or perhaps the villagers going to the specialist (for want of a better term, I have called this the Itinerant Specialist). Either variant would result in the wares of the specialist distributed across the entire village. The houses or units of comparisons would then show high similarity leading to the correct inference of craft specialization. Rowlands (1971:214) has described this pattern for a variety of metallurgists and Donnan (1971:465-466) has described a somewhat similar pattern for itinerant potters in Peru.

The Village Specialist model, Model 5, does not differ greatly from Model 4. The only exception being the presence of the specialist in the village on a full time basis. In the previously discussed model, the specialist may have been in the village for only a short period of time. The uniformity among houses in Model 5 would then result from the direct exchange of products from the individual producers to the consumers. Firth (1959:299) described this pattern in his discussion of Maori econmics:

> Certain persons in the community, however, were specialists in a craft, as such obtained at least a portion of their income through payment for the work which they performed for others. A person who required a stone adze, for instance, but was not skilled in the making of such an implement, would commission an expert to manufacture one for him, and on its completion would hand over a garment or present of food as payment.

Low similarity (distinctness) among units of comparison and the resulting inference of household production can be expected from Models 1, 2, and 6. Models 1 and 2 are clearly in contradiction to the inference concerning the organization of production because they are instances of craft specialization. While these two models, on theoretical grounds, can be expected to provide data leading to an incorrect inference, the models, themselves, are inappropriate for the archaeological situation considered below. Model 1 enables the consumer to choose among among a number of producers in a market context who are manufacturing the same item. If each consumer were to have his own producer on a permanent basis, each household would then appear distinct. A model based upon the market concept is not in accordance with the archaeological data from the Balkan Neolithic. There is simply no evidence for any market system. Further even if a market economy were operating, the number of producers is always <u>considerably</u> smaller than the potential number of consumers. Thus given a large enough sample of units of comparison in the analysis, non-distinctness would show up as the dominant pattern, though subgroups may emerge.

Model 2 based on the concept of trading partners can also lead, on theoretical grounds, to distinctness and the incorrect inference of household production. In this case households have regular trading relationships with households in neighboring villages. If each of the households has a binding relationship with an outside household, distinctness would emerge when some form of specialization is present. This model also seems inappropriate because as a number of authors (Flannery 1968:102-103, Sahlins 1972:282-288, Trigger 1969:36-37, and Turnbull 1963:249-250) have noted, these exchanges normally involve goods which result from highly localized raw materials. That is, a household (A) in one village gives materials from his environment which are not available in the vicinity of his trading partner (B). In exchange, the partner (B) provides the household (A) with materials not present in his area. There is no reason to believe, at this time, that the clay materials necessary for ceramic production during the Balkan Neolithic were localized in their distribution. If this is true, it seems unlikely for ceramics to have been traded in this context. Further Turnbull (1963:229) has noted that among the Mbuti Pygmies, these trading partnerships are not permanently binding. Partnerships are often shifted to allow individuals to maximize their returns. If these trading partnerships do shift, this would lead to a higher level of similarity among units of comparison and possibly make the pattern non-distinct. Thus the Trading Partners model appears inappropriate to explain the variability in the tests considered below.

Model 6 has the production loci for an artifact type within each of the units of comparison. This type of production is aptly described by Herskovits (1940:126):

> Thus in groups where the primary division of labor is along sex lines, every man or woman not only will know how to do all those things that men or women habitually do among them, but must be able to do them efficiently.

Radcliffe-Brown (1934:40-41) described this same situation amongst the Andamanese:

> Besides their food, which they must find from day to day, the natives have need of nothing save their weapons and implements. Of these each person makes his own, each man making his own bow, ✓ arrows, adze, etc., while the wife mades her baskets nets and so on.

It is assumed in this latter situation, however, that there is a direct relationship between the producer of the artifacts and the activity area, which contains the artifacts in question. It is not necessary for the artifacts to be produced in the activity area itself. The artifacts could be produced some distance from the units of comparison, for example a workshop, and subsequently brought back.

It is possible that within each of these models goods within a community will be exchanged among households. The exchanged goods would then lead to high similarity (non-distinctness) among units of comparison and the inference of craft specialization. This exchange, however, would lead to an incorrect inference in Model 6 alone; the other models, all specialist based, would not be affected. While control of this variable is somewhat difficult, this may be approached through the use of objects whose life spans are fairly short. The short life span would then tend to minimize the movement of the items from one household to another. As mentioned earlier, the material used in the tests on the prehistoric artifacts are bowl forms. The life spans of these vessels, if ethnographic analogies are considered, are short. Thus some control over this variable is excercised.

From my reading of the ethnographic literature, there are, indeed, few societies where there is no specialization in the production of material goods. Many societies show household production for most material goods, but a small class of material objects is produced by craft specialists. This is seen amongst the Maori of New Zealand.

Most households produce their own material goods, but some specialization is present within the village in some classes of materials goods such as adzes (Firth 1959). The existence of a system of production based completely on household production seems rare. Instead, a mixed system of household producers and crafts specialists appears to be much more frequent.

Pires-Ferreira (1973) used an approach similar to the exchange models sketched above to analyze patterns of obsidian procurement during the Mesoamerican Fomative Period. Her analysis focused on different types of obsidian as indicated by differing source locations for that obsidian. The obsidian artifacts which were found within houses at various sites reflect socio-political and temporal variation. When types of obsidian differed between houses (low similarity), she argued "that each household may have directly and independently obtained the obsidian which it utilized" (Pires-Ferreira 1973:88). Sites which showed houses sharing uniformly mixed types of obsidian (high similarity) suggested "some form of centralized pooling which resulted in a mixture of incoming obsidian prior to its distribution [to houses within the sites]" (Pires-Ferreira 1973:88). This latter example would be an indication of specialization both in procurement and trade of the obsidian. Thus, she was able to infer changes through time in the way obsidian was acquired.

Previous studies of specialized craft industires in less complex societies have largely focused on exotic materials. These exotic materials have served as markers of possible long distance trade and craft specialization, for example obsidian in the Near East and Mesoamerica, and amber, shell, and copper in Central Europe. In industries not involving exotic materials, the study of craft specialization has been limited. Thus, Evans (1973) in his analysis of craft specialization in the Balkans has primarily relied upon the presence of workshops or hoards to infer specialization. The study of idiotemplates in equivalent and synchronous activity areas promises to clarify the question of craft specialization in industries not utilizing exotic resources.

Additionally, it can serve as a check against the interpretation of craft specialization based upon the identification of workshops. Where workshops have been identified at archaeological sites, high similarity should be present in activity areas where artifacts of that type are found. If not, the workshop might then be interpreted as a communal work area shared by a number of household producers.

More precise information is also provided about intra-village production and exchange; a subject usually ignored in archaeological analyses. In two recent summary articles on prehistoric exchange systems, no discussion is found of intra-village exchange networks (Webb 1974 and Wright 1974). Within village studies can supplement the more prevalent regional or inter-village analyses. The avoidance of intra-village exchange systems is particularly surprising because of the long standing tradition of such studies in cultural anthropology. Wright, though speaking of trade between neighboring villages, stated the problems and importance of these intra-village exchanges (Wright 1974:3):

> These local exchanges deal primarily, but not exclusively with perishable items. As we have noted, these items are difficult to deal with archeologically. Yet undoubtedly they were of far more importance to the subsistence bases of the prehistoric societies than were long distance trade relationships.

Degree of Similarity and Systems of Production

Since artifacts that would be classfied into the same type by the archaeolgoist and probably by the makers are being analyzed, the definition of the degree of similarity which is necessary to permit inferences about the organization of production becomes an important question. How high must the similarity be among units of comparison to infer craft specialization? And how low must the similarity be among compared features to infer household production? Since the objects that are being analyzed would be considered to belong to the same overall mental template, the similarity amongst artifacts of one template should be relatively high when compared to objects that are derived from other mental templates. Therefore, in White and Thomas's study, it would be expected that tools of are type would correlate with one another at higher levels than correlations of are and are kou. That is, within group similarity of are kou should be higher than the cross template correlations. White and Thomas (1972:298) provided some support for this when they stated:

> In the eigenvectors relating to each TMD there is no case in either parish where an eigenvector data reading for are kou is as large as the smallest reading for are. This suggests that members of each parish operated with a clear perception of the size limits appropriate to each tool type and that even a man who prefers very large tools does not select as are many specimens that his fellows reject.

The cross template correlations, depending upon the similarity of the artifacts being evaluated, could also achieve high absolute values, but they should be lower than the within template correlations.

Within the cultural template for a single artifact type, the tools manufactured by one person would correlate with one another at higher levels than with artifacts made by another producer. Since the artifacts of one type are derived from slightly different interpretations of the same template, the absolute correlation values of both sets of comparisons, within a producer and between producers, will be high. However, the within producer correlations should be higher. Empirical evidence from White and Thomas (1972), Gunn (1972), and data to be presented in the subsequent chapters, support this idea. This hierarchical approach to similiarity is essentially equivalent to Clarke's (1968) clustering of attributes, artifacts, types, and cultures into more inclusive categories at specified levels of similarity and many other taxonomic classifications.

At this point, given the limited amount of work available in the area of idiosyncratic variation, it would be difficult and foolish to set up standard sets of criteria which could be used to evaluate idiosyncratic patterning. Each set of comparisons or tests of prehistoric should be treated individually and argued on the basis of the results. An approach to standardization of criteria can be made through the analysis of material culture in contemporary craft industries. In this way, some insight can be gained into the range of variation in individual production that is associated with different materials, classes of objects, and methods of production. It may in the end, however, be impossible to set up standard sets of criteria by which to evaluate these comparisons.

The information necessary to resolve this issue is rapidly disappearing from traditional societies with the introduction of Western goods to even the remotest regions. Chagnon (1975) reported that some of the Yanomamo groups do not manufacture pottery any longer, though contact has been established only recently. Pottery production has ceased with the introduction of aluminum cooking vessels. Longacre (1974) discussed the problems he encountered in finding a suitable ceramic producing population. The anthropological record is now filled with these laments concerning the disappearance of a wide range of traditionally manufactured material objects. The anthropologist and particularly the archaeologist interested in the study of material culture in traditional contexts must quickly study these industries before they disappear. Binford (1973), on the basis of fieldwork amongst the Nunamiut Eskimo, has provided an interesting discussion of some of the interpretive assumptions that many archaeologists have about the material culture found at sites. These studies are gaining currency within the discipline as evidenced by the numerous symposia and publications directed towards ethnoarchaeology. The importance of these studies cannot be overstressed because the data is very relevant to archaeological models of interpretation.

Depite the loss of traditonal crafts in non-industrial societies, it is possible to examine certain assumptions about the nature of material goods in our own and other industrial societies. The complex nature of these industrial groups often supports many craft complexes based upon traditional craft concepts. The study of contemporary potters at Jugtown, North Carolina, described in the next chapter, serves as one example and is directed towards gaining empirical evidence to help answer the questions posed above.

CHAPTER III

POLAR COORDINATES AND THE JUGTOWN CERAMICS

Ceramic Analysis and Idiosyncratic Patterning

Although ceramic analysis has been used to resolve many problems of interpretation in archaeology, the procedures underlying ceramic analysis are themselves problematical. Many of these problems pertain directly to description, the core of ceramic analysis (similar problems are also to be found in other classes of artifacts). Often there is considerable lack of uniformity in practice and particularly in the minuteness of contrasts in the description of a single ceramic type. How black is black or when does sufficient change in any one dimension, e.g. the gradual change from an everted lip to an inverted one, define the presence of a different attribute state? The problem of adequate artifact description is extremely important when small differences resulting from idiosyncratic variation are being examined. I have chosen to measure these small differences by using a new measurement technique: polar coordinates. This procedure, described below, will provide a means for recording the small differences in vessel profiles.

Differences in ceramic forms within a single template shared by a number of potters are generally the result of different interpretations of the template or slight differences in the method of manufacture. The manufacture of vessels by hand makes small variations inevitable in a set of artifacts produced by the same person. In describing the shaping of hand made pottery produced by the women of the Maghreb, Balfet (1965:165) noted:

> This general description leaves room for variations which appear *very slight*, but their various combinations with those of other steps suffice to give *originality to each potter's work*. There are variations to begin with, in the posture of the woman who may be seated, squatting, or standing while leaning over her work around which she moves. There are variations in the installation of the support which may be a simple disk placed on the ground, a slightly convex disk, (which allows movement by hand or foot), or a raised disk, for example an upturned dish. Still other variations are in the thickness and method of lengthening the coils. (Italics mine.)

This quotation is typical of the statements made about recognizing distinct patterns of idiosyncratic variation in a sample of vessels produced by potters who share the same template (Bunzel 1929, DeBoer 1975, Foster 1948, and Matson 1972). These slight differences are sometimes recognized by the potters, and some of this variation is intentional (Matson 1972).

As a result of my own field work in North Carolina, I heard one potter even refuse to acknowledge the sharing of a cultural template with another ceramicist who worked in the same pottery[1]. This woman insisted, and correctly so, that her pots were differently shaped. This difference was not caused by some unconscious interpretation or some variation in manufacture, but instead by a deliberate desire to be consistently different, albeit slightly. However, many archaeologists ignoring the minor differences would classify her vessels into the same shape type as the pots produced by the other ceramicists within her workshop.

More often than not, an artifact shape does not fit any of the

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[1]This woman worked in a pottery other than the one described later in this chapter.

regular geometric forms. Therefore, descriptions often speak of maximum or minimum length when the artifact is highly irregular in shape. Though these dimensions convey information about shape, they do not adequately describe the variations in shape that occur within even a single artifact, let alone among a population of artifacts.

This lack of correspondence between shape and descriptive dimensions is also true for ceramic artifacts[1]. Basic broad categories are established such as plate, bowl, jar, and pitcher to define for the reader the primary vessel shape. Vessel shapes are ordinarily complex geometric forms that differ greatly within even a single vessel type based on shape.

The definition of research goals by the archaeologist must be accompanied by procedures for evaluating the data gathered to answer these questions. The study of minor differences in shape resulting from idiosyncratic variation is no exception. It is necessary to devise a procedure for adequately measuring idiosyncratic variation in vessel shape. The procedures discussed by Shepard (1965:224-251) have served a good job of differentiating basic forms, but no procedure is provided for discussing the minor variations within a single type. These minor variations are generally subsumed under ordinal differences such as more rounded shoulder, lower base angle, and slightly more everted lip (O'Brien 1971). Little attention has been paid toward the definition of the boundaries, if any, between these ordinal categories. This precludes the replicability of the study on the same or different materials

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[1]Eric and Stickel (1973) discussed a successful approach for estimating vessel volume by dividing vessel shapes into a series of standard geometric forms for which volume can then easily be calculated.

by another investigator.

Other devices that have been used include ratio scales such as vessel height/rim diameter. At best, these ratios are an indirect measure of vessel shape. They do not use all the available data along the vessel profile. Shepard (1965:238) acknowledged the deficiencies of these ratio scales when she stated: "Overall dimensions fully describe the proportion of only a few special shapes; the more complex the contour becomes, the greater the inadequacy of this basic ratio alone." In concluding her discussion on the description of shapes, Shepard (1965: 244) remarked: "The number of proportions or indices will depend upon the purpose of shape analysis. If the object is merely to distinguish low, medium, and tall vessels the overall index is all that is needed, but if a more systematic comparative study of contours and proportions is to be made, more precise definition is required . . . ."

Even if the traditional dimensions and ratio measures were advanced to more complex levels, including multivariate analysis, in which measures would be considered simultaneously to produce groupings or clusters according to similarity, these studies would suffer from the same problem: the basic dimensions or ratios are an indirect measure of vessel shape and would not reflect the minor variations resulting from individual differences.

Many of these dimensions or ratios can only be recorded for complete vessels. Therefore, systematic analyses of vessel shape utilizing these measures and based upon rim sherds would suffer from even more problems. Several of the important dimensions and ultimately ratios could not be recorded because the points necessary for their measurement are not located on the sherd.

One may conclude, therefore, that the traditional dimensions and ratio scales are woefully inadequate for the study of minor variations in vessel form which might result from idiosyncratic variation. A system is needed to describe vessel shapes represented by either complete vessels or rim sherds. This system should also overcome some of the problems inherent in the intuitive and undefined ordinal categories. Finally, it should consider the data presented along the entire vessel profile.

One system which can be used to overcome these difficulties is based upon the use of polar coordinates to approximate the vessel shape[1]. Polar coordinates are used to locate any point in a field with references to its distance from the origin and angle from the polar axis. The points to be located within the polar coordinate field for the analysis of pottery shapes would not be the various and infinitely continuous set of points along the vessel profile.

A series of concentric circles at 0.5 mm intervals surround the origin and allow the distance to be computed efficiently. The distance is then calculated by noting the circle that the point comes closest to touching. The angle is also measured efficiently by a series of straight lines or rays that emanate from the origin at one degree intervals. The angle is then computed by seeing what line the point comes closest to touching.

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[1]Previous uses of polar coordinates within archaeological analyses have included the determination of edge angles and location of retouch on lithic artifacts (Wilmsen 1967) and the shape of striking platforms on cores (Gunn 1971). I am indebted to Joel Gunn for his discussions with me about the application of polar coordinates as a means of recording vessel shape.

For the purposes of analyzing the pottery, a plane perpendicular to the graph paper at the horizontal or polar axis forms the plane of orientation for the rim of the vessel or sherd. The shape of the vessel can be reproduced by plotting the points at the intersection of the rays with the vessel profile. In essence the shape of the vessel is simulated by the plot of points of intersection. With the addition of more rays, and hence more points along the vessel outline, the simulated shape more closely approximates the actual shape of the vessel. A vessel shape (figure 58) is analyzed by the polar coordinate method using lines emanating from the center at 10 degree intervals (figure 59) and 5 degree intervals (figure 60). Note the more accurate representation of the vessel shape at 5 degree intervals than at 10. Finally, a set of interval data is derived from each vessel. These data reflect the distance of each straight line, at 5 degree intervals, from the locus to the point of intersection along the vessel wall (see table 3).

Therefore, amongst vessels scaled equally in height and rim diameter, the differences in the set of measures for each pot are indicative of differences in vessel shape. Table 4 provides a comparison of two differently shaped vessels. The first column repeats the data from table 3 for the vessel shown in figure 58. The second column provides the interval data for the vessel shown in figure 61. Figure 62 shows this vessel with the polar coordinate overlay. Measurements have been taken at 5 degree intervals for each vessel. Table 4 shows that the equally scaled vessels have considerably different sets of measures. Thus the polar coordinate data can be used to record vessel shape.

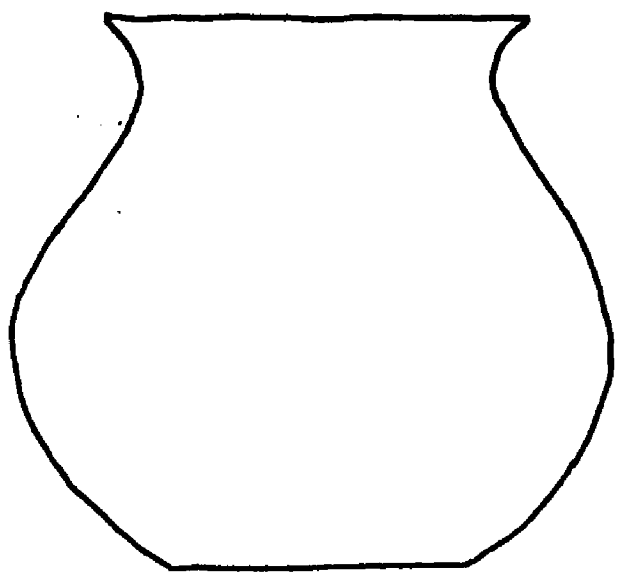

Fig. 58. First Vessel Used in the Polar Coordinate Analysis.

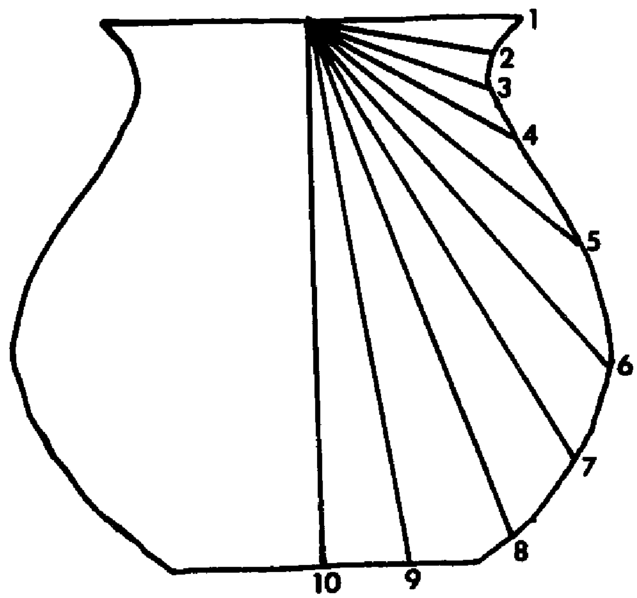

Fig. 59. First Vessel at Ten Degree Intervals

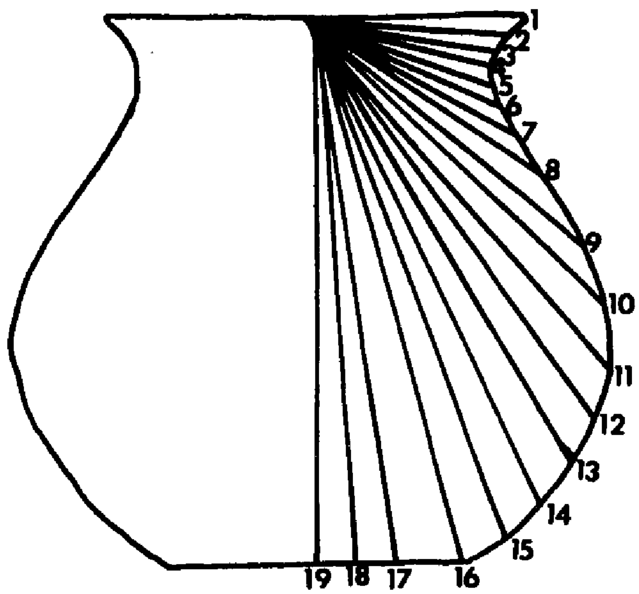

Fig. 60. First Vessel at Five Degree Intervals.

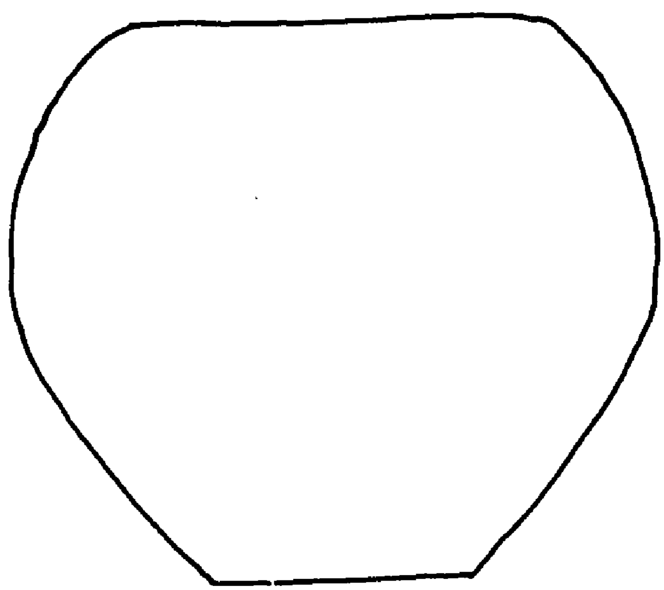

Fig. 61. Second Vessel Used in the Polar Coordinate Analysis.

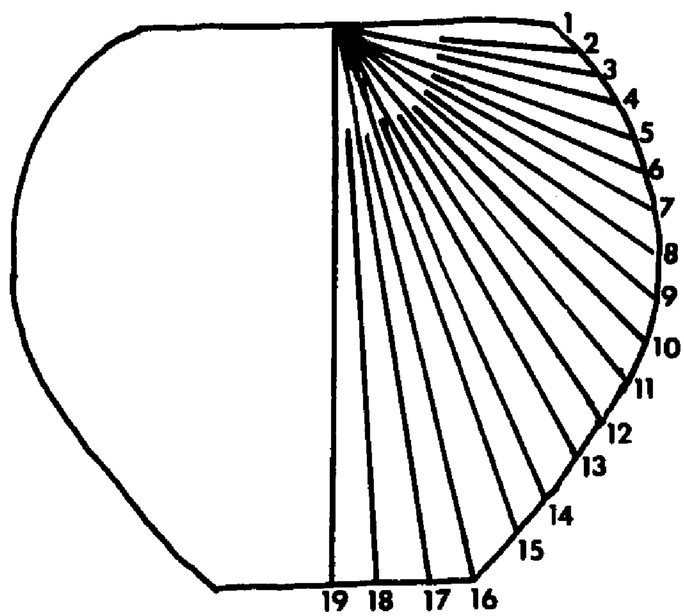

Fig. 62. Second Vessel at Five Degree Intervals.

TABLE 3

POLAR COORDINATE DATA FOR VESSEL SHOWN IN FIGURE 58 AT 5 DEGREE INTERVALS

Ray	Distance from Locus in mm	Ray	Distance from Locus in mm
1	26	10	52
2	25	11	58
3	24	12	61
4	23	13	65
5	24	14	68
6	26	15	69
7	29	16	70
8	35	17	69
9	45	18	69
		19	69

TABLE 4

COMPARISON OF TWO DIFFERENTLY SHAPED VESSELS SCALED EQUALLY IN HEIGHT AND RIM DIAMETER

Ray	Distance from Locus (mm) (1)	Ray	Distance from Locus (mm) (2)
1	26	1	26
2	25	2	29
3	24	3	32
4	23	4	35
5	24	5	39
6	26	6	42
7	29	7	46
8	35	8	48
9	45	9	52
10	52	10	55
11	58	11	56
12	61	12	59
13	65	13	61
14	65	14	63
15	69	15	66
16	70	16	70
17	69	17	71
18	69	18	70
19	69	19	69

The approach proposed here has several advantages over the more traditional measures discussed earlier. First, the data are a direct measure of shape. The rays that emanate from the origin cover the entire vessel profile rather than selected parts. By increasing the number of rays, it is possible to simulate the shape more closely. The number of rays that cover any one area of the vessel can also be increased without distorting the analysis. This can be accomplished if all the vessels are analyzed using the same format. In this way the data are comparable for each vessel. The change in the frequency of rays can be determined by the investigator to fit certain research problems. If more information is desired about differences in the bottom portion of the vessels, the frequency of rays for this area can be increased.

Second, these measures could be checked against the same or similar samples by another investigator. Hence, the reliability of the measures and their subsequent use is improved. Some of the measures proposed by Shepard are subject to interpretation. This is especially true for those points which define the transition from one part of the vessel to another, e.g. neck to shoulder.

Third, the data can then be used to measure the differences or similarities that exist between any two vessels in an assemblage. This can be accomplished through the use of coefficients of similarity or distance that are described by Sokal and Sneath (1963) and Johnson (1973). These differences or similarities can be used to establish classifications or clusters based upon similarity in shape. In a test conducted on a set of whole vessels from Divostin, the classification achieved with the polar coordinate data coincided with the intuitively established shape categories (Kaufman 1972).

Fourth, it should be possible to measure the minor differences that are found within each shape type. These differences should be reflected in the set of interval data taken for each vessel. This set of data can then be used to construct clusters based upon similarities or differences in the vessel profile. In the above mentioned study on the Divostin whole vessel sample, the two large bowl clusters, each associated with a different shape type, showed subdivision into smaller clusters. These smaller groupings probably reflect the minor differences in shape caused by idiosyncratic variation found within the profile types. Thus, this approach can be used to measure the idiosyncratic patterns of vessel formation in ceramic assemblages.

Fifth, the investigator can work inductively to find those areas of the vessel wall that vary most significantly. This can be accomplished through the previously discussed Principal Components Analysis. The components can be analyzed to see wich rays or straight lines discriminate between individuals most efficiently.

Given the general proposition that idiosyncratic variation is both present and recognizable within artifact assemblages, the point approximation method will be evaluatd against a contemporary assemblage of ceramics belonging to the same shape template. If the evaluation of the contemporary assemblage from Jugtown shows idiosyncratic patterning, then the validity of the point approximation approach using the polar coordinate measuring technique for recording minor variations in form within ceramic populations is established. Additionally this same method, if validated will be used to evaluate a sample of rim sherds from the site of Divostin. Thereby, a measure of craft specialization in the Late Neolithic may be provided.

Conditions for Using a Contemporary Ceramic Sample to Test the Point Approximation Approach

In order to evaluate the point approximation technique's ability to reflect idiosyncratic variation, a "contemporary" sample of ceramic vessels was needed which had to fulfill the following conditions:

1. All of the vessels had to belong to the same mental template for shape shared by a community of potters. This is important because the variation found within the sample would then reflect idiosyncratic differences amongst the producers
2. Each pot had to be identified according to the maker. The identification of the makers of each of the vessels would then permit pairwise comparisons to be made to determine if the measurement system can, indeed, isolate individual differences
3. Several potters had to be included in the study. The use of several potters within the study would minimize the possibility of sampling error in the tests to be concluded. This would provide a series of pairwise comparisons to be performed similar to those conducted with the Aluni knappers
4. Each potter had to be represented by a "large" sample of pots. Sampling error would also be reduced if each potter had many of his pieces included in the test. The greater number of vessels would presumably be a more accurate representation of the range of variation in vessel shape permitted by that producer
5. The vessel shape included in the study had to be of a complex nature. This is important for two reasons. First, a complex form, defined by the presence of two or more changes in direction

along the vessel profile, would introduce greater variation in form into the study. A straight walled vessel would offer little variation in form by accomplished potters. Second, the prehistoric sample of sherds from Divostin includes sherds which have two or more changes in vessel profile. Therefore, the ethnographic situation would more accurately mirror the prehistoric conditions if complex vessel forms are used in the analysis

I expended considerable effort to secure a population of vessels that was located in a museum or educational institute, or even owned by a private collector. Each possible source was eliminated as each sample did not meet one of the conditions. I even expanded my range of usable materials to include photographs, provided that one dimension, i.e. vessel height or rim diameter, was supplied, but to no avail. As is often the case, data collected for one purpose are often not suitable for the research aims of another person, particularly if the other person is interested in a very narrowly based problem such as idiosyncratic variation. Many museums have extremely large collections of pots, but they could not usually be identified according to maker. These collections acquired during the latter part of the 19th and early part of the 20th centuries were not meant to answer problems like the one considered here. It was, therefore, necessary to conduct my own fieldwork amongst a group of potters who shared a cultural template for their products.

Jugtown: A Contemporary Ceramic Producing Community

Finding a suitable ceramic producing village or community within the United States given the lack of funds to support this work was extremely difficult. Though hundreds of pottery studios and several communes exist in the nearby New York area, they could not be used because the potters within each of these "sites" did not share a common template for vessel forms. The overriding concept was one of extreme individuality, which resulted in the production of a highly differentiated sample of pottery. Vessels from these places could not be considered to belong to the same template because of the great variation which existed amongst the pots.

Eventually I had the good fortune to contact Fred Matson and Charles Counts, who directed me to one of several pottery producing communities within Appalachia. Both men spoke highly of one community, appropriately named Jugtown, which is located about 60 miles due south of Greensboro, North Carolina. Jugtown is noted for the high quality of its wares and the cooperation shown by the potters to outsiders interested in their work. I immediately contacted the director of the workshop, Ms. Nancy Sweezey, with whom arrangements were made to visit the workshop during the second week of January, 1975.

After arriving at the workshop, its suitability as a source of vessels to use in my research quickly became apparent. The pottery consisted of five potters, including two apprentices. The ceramics were made for marketing throughout much of the continental United States. The shared template was acknowledged by the potters, though not every potter made all the various shapes produced by the pottery. The standardization of form within one vessel type based on shape was also ensured by the presence of a mail order catalog which had pictures of the various types of pottery for sale from Jugtown. Since much of the business was conducted through the mails, "major" deviations from the standard forms occur as deliberate experiments to develop new pottery shapes to be included in the next catalog or presented in craft fairs. The range of shapes produced by the pottery, however, has remained fairly uniform throughout the years.

Since most of the wares had been shipped out in anticipation of the Christmas holidays, the pottery did not have many types of vessels on hand. Therefore, it was necessary to have the pots produced especially for the research project. In order to elicit the cooperation of the other potters within the community, it was necessary to inform them of the nature of the project prior to their participation. The problem of possible bias was unfortunately introduced into the analysis at this point, though it seems to have been negligible based upon the results to be presented below. Each potter produced his/her wares in different rooms,out of contact with the other potters participating in the experiment. Thus, no potter was aware of what the other potter had done until each had finished his/her own work. All agreed that they shared a template, but could easily distinguish the work of their fellow potters on the basis of small and regular differences amongst their vessels.

The shape of the vessel to be used in the experiment had to fulfill all these criteria. The vessel shape was to be of complex form, having at least two changes in direction along the vessel profile. The vessel form was to be produced by more than two potters within the community. After some discussion with Ms. Sweezey, it was decided that a pitcher form would be used in the experiment. The pitcher could satisfy all the requirements, having three changes in direction along the vessel profile (figure 63), and would be produced by three of the potters:

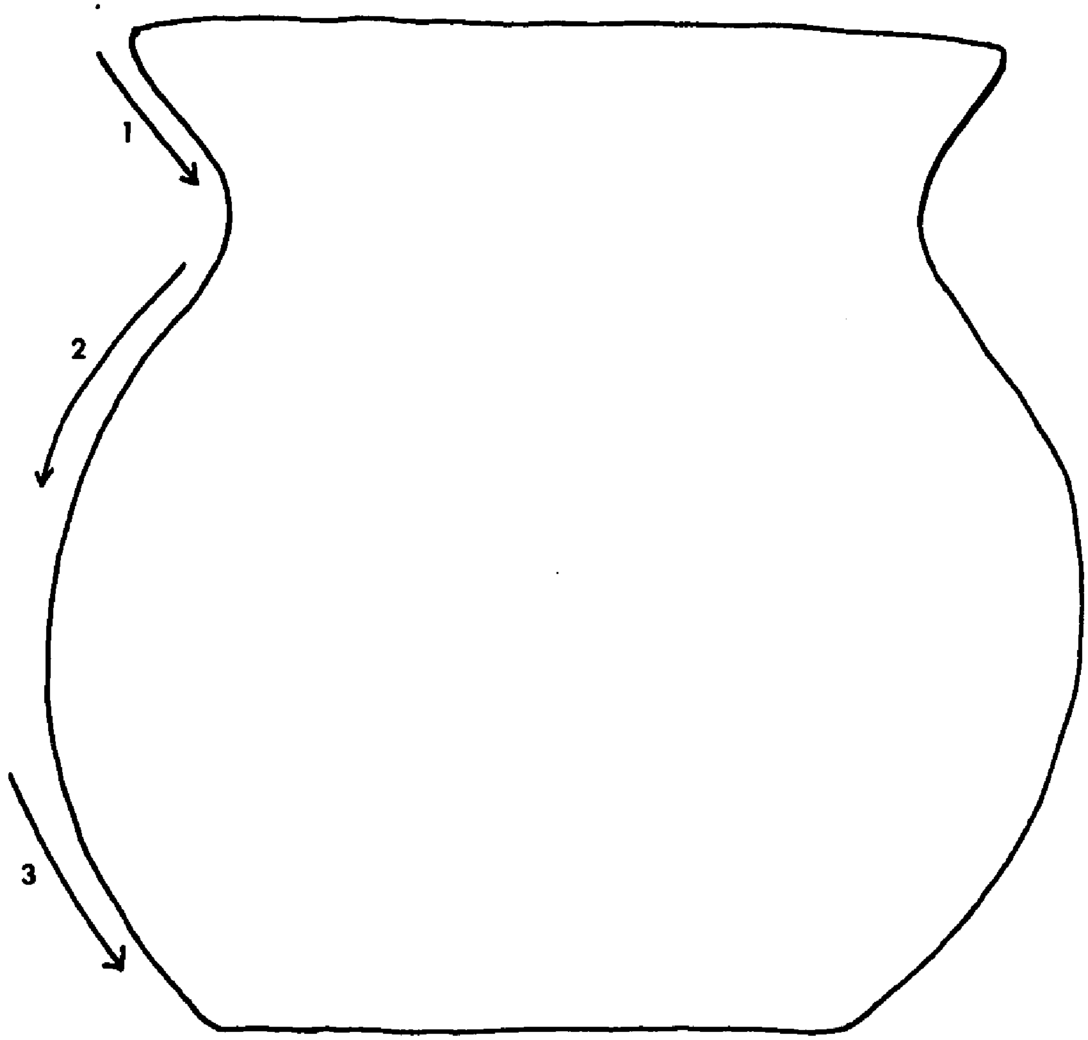

Fig. 63. Jugtown Vessel Form.

Nancy Sweezey--Potter A
Bill Russell--Potter B
Ben Owens--Potter C

Additionally, the product would be used by the pottery in their mail order business, ensuring standardization at the template level. It was further agreed that each potter would produce 15 vessels. This is a large enough sample to allow for individual differences to manifest themselves, if the Aluni and Gunn's experiments can be used as a gauge of necessary sample size. In both situations, each knapper was represented by less than ten items.

Ideally, it would have been preferable to use vessel shapes that were comparable to the prehistoric situation, but this was impossible because the Divostin bowl shapes have no analogs in the Jugtown repertoire.

The pitcher shape used in this study was only a preliminary form in the production of the final artifact. Pitchers have pinched and everted lips along one section of the rim and a handle directly opposite on the outside wall. Therefore, it was decided to record the vessels' profiles before these features were added. In this way, the vessels would be as nearly symmetrical as the method of manufacture and individual abilities would permit. The handle and pinched rim would make the vessels asymmetrical and less suitable for the study. Each of the three potters threw their vessels on fast wheels and generally took less than one hour each to complete their work, including the preparation of the clay. The vessels manufactured by each ceramicist are shown in figures 64, 65 and 66.

Since the analysis rests upon the recognition of the minor variations in vessel form, it was necessary to obtain a precise definition

JUGTOWN POTTER A-NANCY SWEEZEY

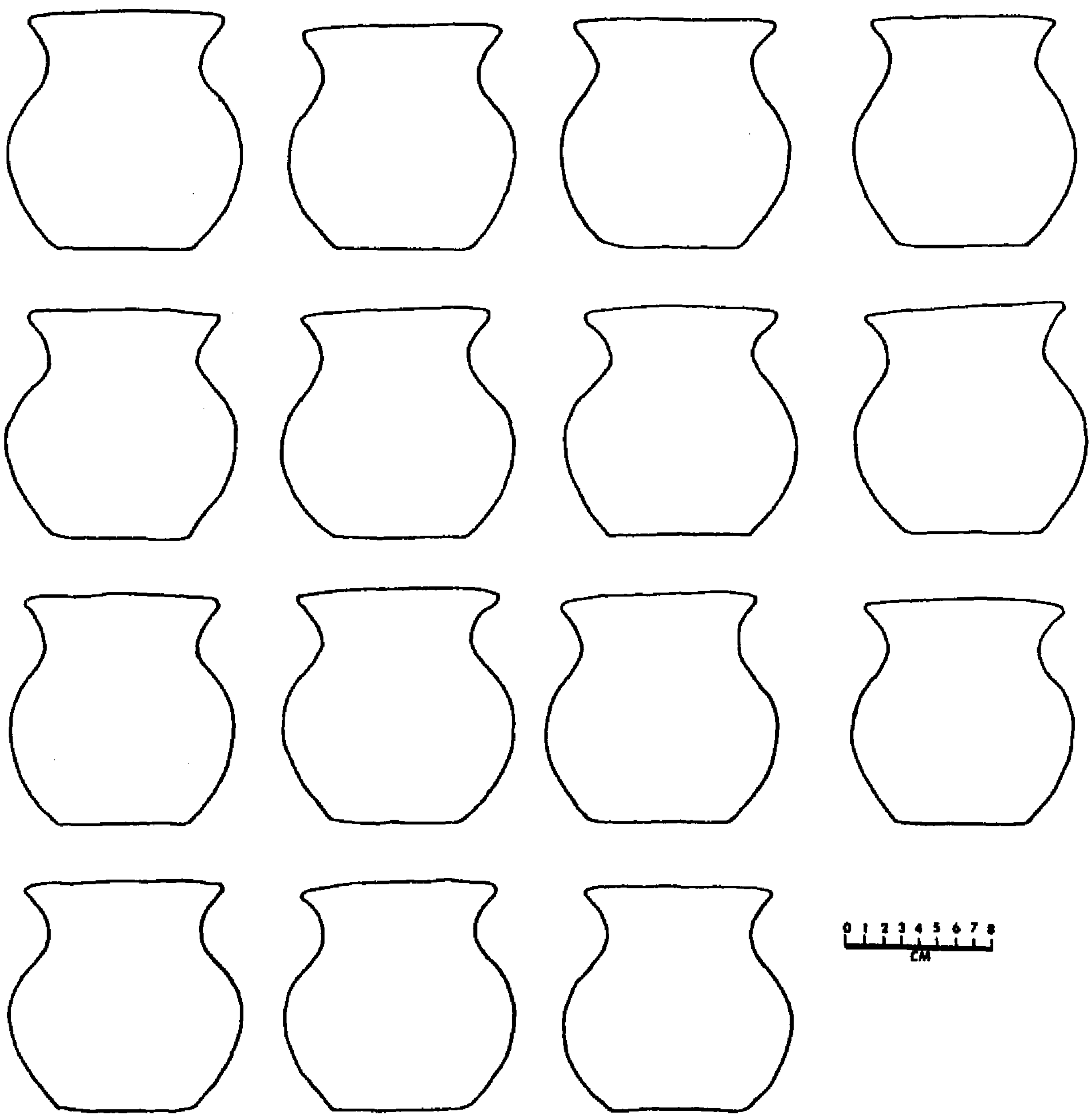

Fig. 64.

JUGTOWN POTTER B-BILL RUSSELL

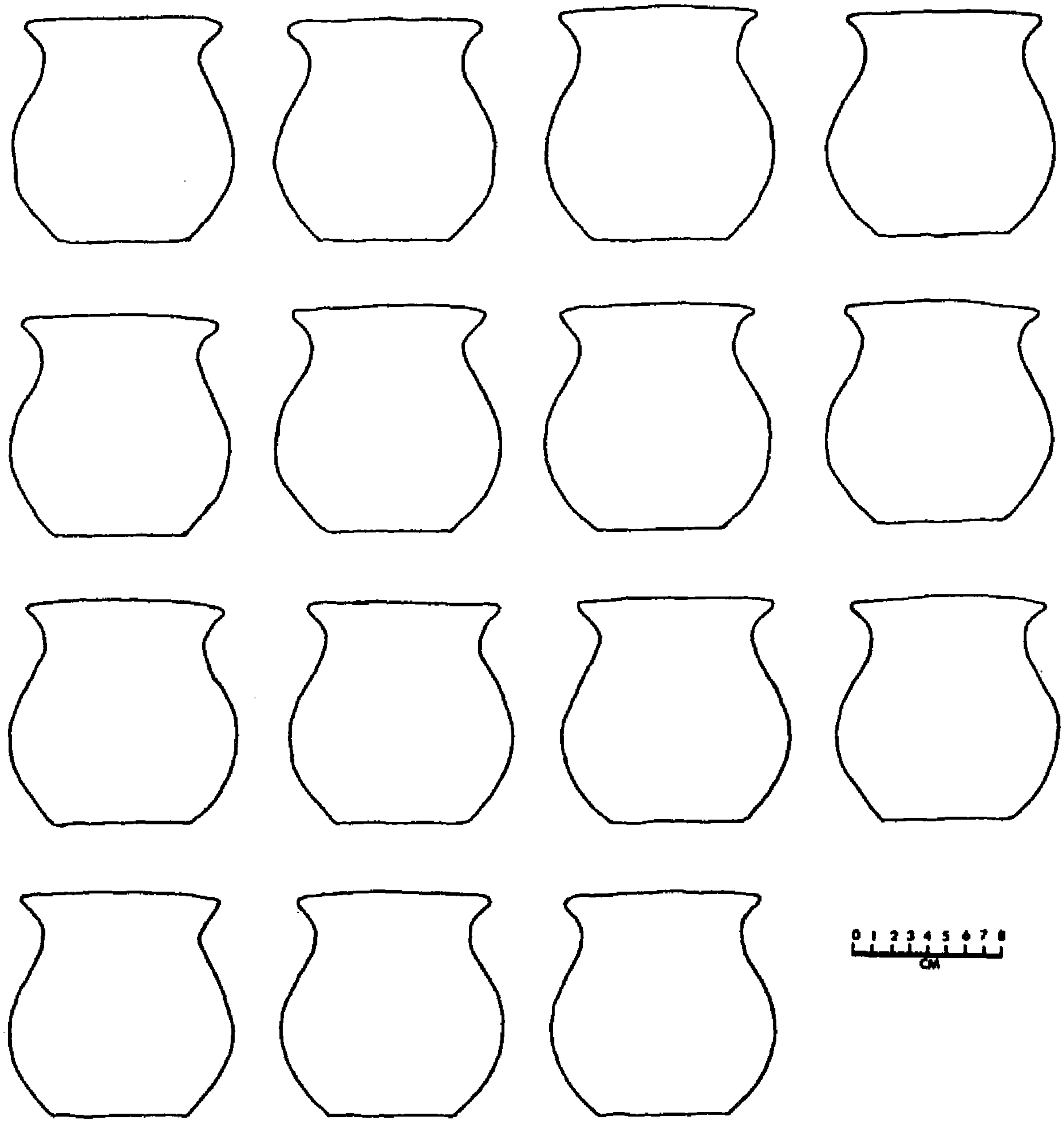

Fig. 65.

JUGTOWN POTTER C-BEN OWENS

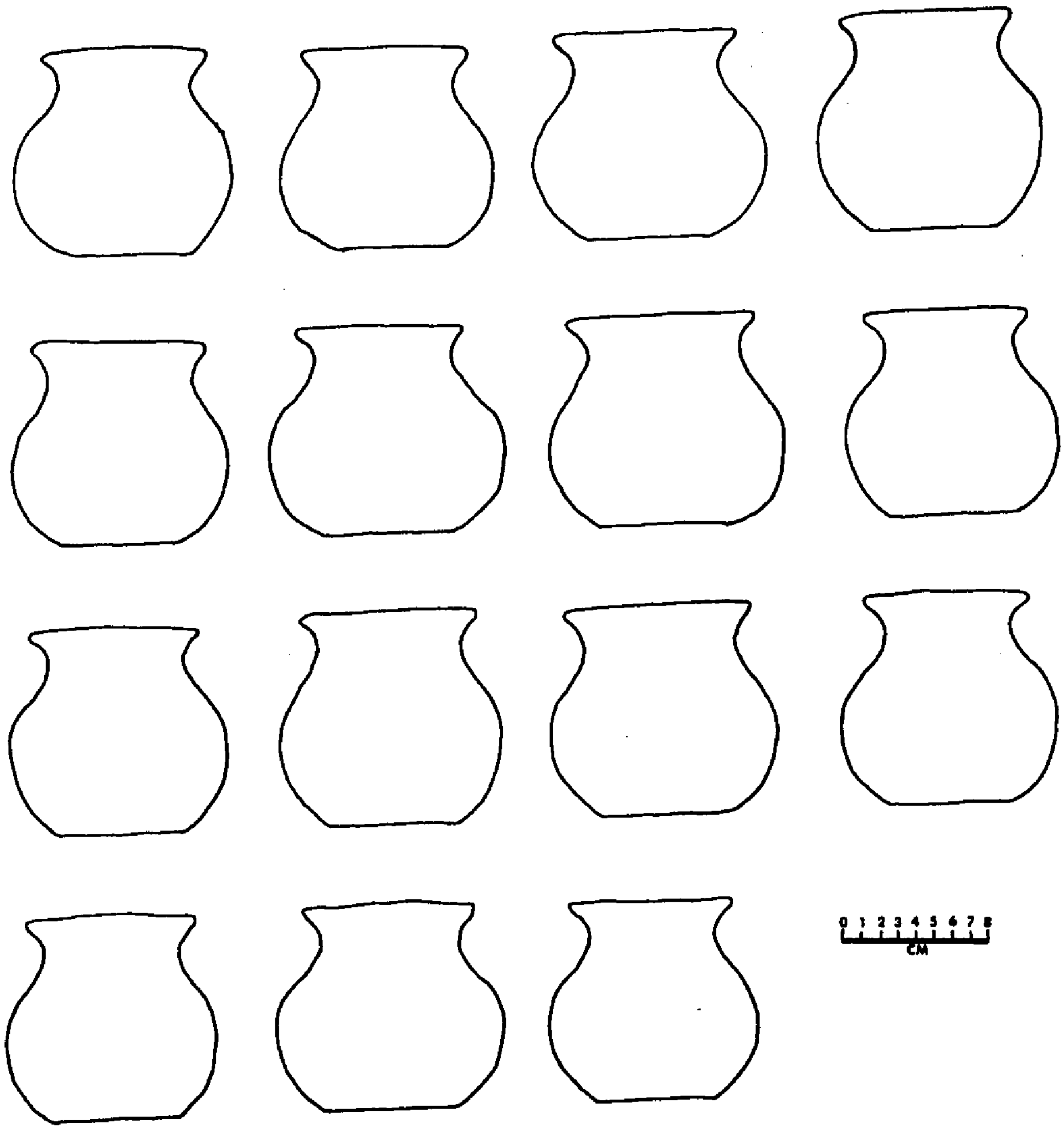

Fig. 66.

of vessel shape from which the polar coordinate measures could be taken. It was impossible to use the sample of vessels directly because they were to be used by the pottery to fill their mail orders. Therefore, photographs of the pots were taken. These photographs would accurately record the profile of each vessel to be used in the study.

Jugtown Analysis Using Authorship Scores

Since the photograph paper was too opaque to allow for direct measurement of the profiles from the photographs, tracings were made from the photos at one-half actual size. The tracings were then oriented along the polar coordinate paper and measured in the manner described above. Two sets of measurements, one for the right side of the vessel and the other for the left side of the vessel, were taken at 5 degree intervals, 0 through 90 degrees, resulting in a set of 19 measures for each side of the vessel, or a total of 38 measures for the entire pot. The first measure for each side of the same vessel would be identical since it represents the radius of the pot. Similarly, the last measure for each side of the same vessel would be identical because it represents the height of the vessel.

The use of both sides of the vessels in these comparisons is justified on two grounds. First, the vessels are slightly asymmetrical, and the use of both profiles provides a more representative sample of the range of variation in vessel form associated with each potter. Second, if similar results are achieved with the profiles from both sides of the vessels, the validity of the measure of distinctness is established.

The data from each of the ceramicists were used in pairwise comparisons, resulting in three different combinations of potters:

Potter A-Potter B
Potter A-Potter C
Potter A-Potter C

The first six comparisons matched right profiles with right profiles and left profiles with left profiles. The results of these first tests indicated that individual potters could be clearly distinguished. The measure, therefore, was validated, and it was not necessary to make comparisons where right and left sides would be matched.

The data were first compared by examining the raw scores for each of the rays in the pairwise comparisons. Each ray was scored for its ability to discriminate between potters. This score, referred to as an authorship score, was determined by establishing a measure in the range of that ray which would best separate one potter from the other. For example, table 5, the comparison of raw scores from the right vessel profiles of Potters A and B, showed that Ray 1 has an authorship score of 2. This was calculated in the following way. Potter A has a range of values from 130-140 mm, whereas Potter B has a range from 115-130 mm. They overlap on the value of 130 mm. Since Potter A has produced four profiles with a value of 130 mm compared to only two profiles for Potter B, this value is assigned to Potter A. Where overlap does occur, these values are assigned to the potter with the greater number of profiles in that range. Thus, Potter A is given the range of 130-140 mm, and Potter B is assigned the values 115-125 mm. Potter B, then, has two profiles which fall into the range of Potter A. The ray received an authorship score equal to the number of profiles of one potter falling into the range of the other producer, in this case 2. The score which would show the most separation between potters is 0. An examination of table 5 shows that Rays 16 through 19 have perfect authorship scores as the range for each potter in these rays is mutually exclusive. The authorship scores for each of the rays in the comparisons are located beneath the columns of raw scores, tables 5-10.

These scores indicate that all potters can easily be distinguished from one another if only certain rays are used. This shows that some rays are better indicators of individual differences than others. Since these rays can be attributed to certain areas along the vessel profile, it is possible to describe the differences between potters. An examination of table 5 shows that the best authorship scores are located in the first and last five rays. This indicates that Potter A made her pots with wider mouths, necks, and bases, and greater height than Potter B. Similar observations can be made in the other comparisons, demonstrating that the crucial differences which distinguish one potter from the other are the rays associated with the top and bottom of the vessel profile. Though the template is obviously shared, each potter has a distinct idea about certain parameters of the vessel profile, namely vessel height, rim and base diameter, and shape of neck. These differeing idiotemplates are implemented in the manufacture of the vessel.

An examination of the authorship scores also shows that there are differing degrees of distinctness associated with each potter. This can be measured by summing the authorship scores for each of the 19 rays in the comparisons. Table 11 presents this data. The lower totals reflect greater distinctness between potters.

TABLE 5

JUGTOWN RIGHT PROFILE A AND B *

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1501	130	135	130	120	120	120	120	125	140	215	245	270	290	305	320	330	320	320	315
1501	130	130	120	120	115	115	120	125	150	210	240	265	285	300	315	330	325	320	320
1501	130	130	130	120	120	120	120	125	135	200	240	270	290	305	320	335	330	325	320
1501	135	130	130	120	120	120	120	125	150	205	240	265	280	300	310	325	320	320	320
1501	140	135	130	120	120	120	125	130	140	220	250	270	290	305	320	330	325	320	320
1501	140	140	130	125	125	125	125	135	180	225	250	280	295	310	325	330	325	320	315
1501	135	135	130	120	115	115	115	120	150	220	250	275	295	310	325	330	325	320	320
1501	140	140	135	130	125	125	125	130	150	220	250	275	290	310	320	330	330	325	320
1501	140	135	130	120	120	120	120	130	150	210	250	270	290	310	320	330	330	325	320
1501	140	135	130	120	120	120	125	130	150	220	245	270	290	310	325	330	325	320	320
1501	140	130	130	120	120	120	120	125	130	200	235	260	280	300	310	325	320	320	315
1501	140	135	130	120	120	120	120	130	150	220	240	270	285	305	320	325	320	315	315
1501	140	130	130	125	120	120	120	125	130	180	240	270	290	315	330	345	340	335	335
1501	140	140	130	125	120	120	120	125	150	225	250	285	290	310	325	335	330	330	330
1501	140	140	130	125	120	120	125	130	150	220	245	270	285	305	320	330	325	320	320
1502	120	115	110	105	105	110	120	140	200	240	260	200	290	300	305	300	300	295	290
1502	125	120	115	110	110	115	120	135	200	230	250	275	290	300	300	305	300	295	270
1502	130	130	125	120	120	120	125	140	170	230	255	285	300	310	315	310	305	300	300
1502	120	120	115	110	110	110	115	125	155	210	240	260	280	295	305	310	305	300	300
1502	120	120	125	110	110	110	110	120	150	220	240	260	280	300	310	320	315	310	305
1502	120	130	120	115	115	120	120	135	170	225	250	270	285	300	305	310	300	300	300
1502	120	120	115	110	110	110	115	125	150	205	230	250	270	280	290	290	270	285	285
1502	115	110	100	095	095	095	100	110	130	190	220	245	260	270	280	290	285	280	280
1502	115	110	110	105	100	100	105	110	130	190	220	250	265	280	285	290	285	280	280
1502	120	120	115	110	105	105	105	115	130	185	220	245	265	285	295	300	290	290	290
1502	115	110	110	100	100	100	100	105	120	200	225	250	270	290	300	310	300	300	300
1502	115	110	105	100	100	100	100	110	130	200	235	260	280	290	300	300	275	290	290
1502	120	120	120	115	110	110	110	120	140	270	240	260	280	290	300	300	295	290	290
1502	115	110	110	105	100	100	100	110	130	195	220	245	260	280	290	300	295	290	290
1502	120	110	115	110	105	105	110	120	150	205	230	255	270	285	300	300	300	290	290
	2	2	1	1	2	3	5	7	11	10	8	5	6	4	2	0	0	0	0

*Authorship scores appear in larger print beneath the computer printed columns for each ray. The first fifteen rows of numbers represent the profiles of one potter and the second set represents the profiles of the other potter. This note is applicable to tables 5 through 10.

TABLE 6

JUGTOWN LEFT PROFILE A AND B

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2501	130	125	120	115	110	110	110	120	130	215	245	270	290	305	320	325	320	315	315
2501	130	130	120	120	115	115	120	125	150	210	240	260	265	300	315	325	325	320	320
2501	130	130	120	120	120	120	120	130	150	220	255	260	295	310	320	325	320	320	320
2501	135	135	130	120	170	170	125	130	160	220	250	275	290	305	320	330	320	320	320
2501	140	140	130	125	120	120	120	130	150	215	245	270	290	305	320	330	325	320	320
2501	140	140	125	120	120	120	120	130	150	215	245	270	290	300	315	325	320	315	315
2501	135	130	135	125	120	120	120	120	130	210	250	270	290	305	325	335	325	320	320
2501	140	130	130	120	120	120	120	125	135	210	245	270	290	305	320	330	325	320	320
2501	140	135	135	130	130	130	130	135	150	220	250	270	295	310	325	330	[illegible]	320	320
2501	140	135	130	130	125	125	125	130	140	200	230	260	280	300	320	330	[illegible]	325	320
2501	140	140	140	135	130	130	130	135	155	210	250	270	290	300	320	330	320	320	315
2501	140	140	135	130	125	125	130	135	150	200	240	265	280	300	295	325	320	315	315
2501	140	135	135	130	125	125	125	135	150	210	250	280	300	320	335	345	340	325	335
2501	140	135	170	125	120	120	120	125	140	210	250	270	290	305	320	335	330	330	330
2501	140	140	130	125	125	120	125	130	160	220	250	270	295	310	325	330	335	320	320
2502	120	120	110	105	100	105	110	120	150	220	245	265	280	295	300	305	300	295	290
2502	125	125	120	115	110	110	110	120	150	210	245	260	280	290	300	305	305	295	290
2502	130	130	125	120	120	120	125	135	160	210	250	270	290	300	310	310	305	300	300
2502	120	125	120	110	110	115	120	130	160	210	245	265	280	300	310	310	305	300	300
2502	120	120	115	110	110	110	110	120	150	220	240	260	280	300	310	320	310	310	310
2502	130	130	130	125	120	120	125	135	165	210	245	265	280	295	305	305	300	300	300
2502	120	125	120	115	115	115	120	130	150	200	235	255	270	285	290	300	290	285	285
2502	115	120	110	105	105	105	110	120	150	200	235	255	270	285	290	290	285	280	280
2502	115	120	110	100	100	100	105	110	140	205	230	250	260	275	285	290	285	280	280
2502	120	120	120	110	110	110	110	120	140	200	230	255	275	290	300	300	295	290	270
2502	115	120	120	110	105	105	105	110	130	210	240	260	285	300	305	310	300	300	300
2502	115	120	115	110	105	105	105	110	130	190	225	250	270	285	300	300	295	290	290
2502	120	120	115	110	105	105	110	120	150	220	245	260	280	290	300	300	300	290	290
2502	115	110	110	105	105	105	110	125	160	215	245	265	280	290	300	300	295	290	290
2502	120	120	115	105	105	105	110	120	180	210	240	255	275	290	300	300	295	290	290
	2	3	5	3	4	4	.5	7	12	12	8	4	4	4	1	0	0	0	0

TABLE 7

JUGTOWN RIGHT PROFILE A AND C

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1501	130	135	130	120	120	120	120	125	140	215	245	270	290	305	320	330	320	320	315
1501	130	130	120	120	115	115	120	125	150	210	240	265	285	300	315	330	325	320	320
1501	130	130	130	130	120	120	120	125	135	200	240	270	290	305	320	335	330	325	320
1501	135	130	130	120	120	120	120	125	150	205	240	265	280	300	310	325	320	320	320
1501	140	135	130	120	120	120	125	130	140	220	250	270	290	305	320	330	325	320	320
1501	140	140	130	125	125	125	125	135	180	225	250	280	295	310	325	330	325	320	315
1501	135	135	130	120	115	115	115	120	150	220	250	275	295	310	325	330	335	330	320
1501	140	140	135	130	125	125	125	130	150	220	250	275	290	310	320	330	330	325	320
1501	140	135	130	120	120	120	120	130	150	210	250	270	290	310	320	330	330	325	320
1501	140	133	130	120	120	120	125	130	150	220	245	270	290	310	325	330	325	320	320
1501	140	130	130	120	120	120	120	125	130	200	235	260	280	300	310	325	320	320	315
1501	140	135	130	120	120	120	120	130	150	220	240	270	285	305	320	325	320	315	315
1501	140	130	130	125	120	120	120	125	130	180	240	270	290	315	330	345	340	335	335
1501	140	140	130	125	120	120	120	125	150	225	250	265	290	310	325	335	330	330	330
1501	140	140	130	125	120	120	125	130	150	220	245	270	285	305	320	330	325	320	320
1503	135	135	130	120	120	120	125	140	170	210	240	270	285	300	310	320	320	315	310
1503	125	130	130	120	115	115	120	130	150	190	240	265	285	300	310	325	320	320	315
1503	135	135	130	120	120	120	125	130	150	210	240	270	290	310	320	335	330	325	320
1503	130	130	130	120	120	120	120	130	150	200	230	260	280	295	310	320	320	310	310
1503	130	130	130	120	120	120	120	130	150	200	235	260	280	300	310	325	320	320	315
1503	135	135	130	120	120	120	125	135	160	200	230	260	280	300	310	325	320	315	310
1503	135	130	130	125	120	120	125	140	160	210	240	265	285	300	315	320	315	310	310
1503	130	130	125	120	120	120	120	130	140	200	230	260	280	300	310	320	315	310	310
1503	135	135	130	120	120	120	125	135	160	205	235	265	280	300	310	320	320	315	310
1503	135	135	130	125	120	120	125	135	160	200	225	265	280	300	310	320	315	315	310
1503	135	135	130	120	120	120	120	130	150	190	225	250	270	290	305	320	320	310	310
1503	135	135	125	120	120	120	120	130	160	200	230	260	280	295	305	320	310	310	310
1503	130	130	130	120	120	120	125	135	160	205	240	265	280	295	305	315	310	310	310
1503	130	130	130	120	120	120	125	135	155	200	230	260	280	290	305	320	310	310	310
1503	130	130	120	115	115	115	120	130	155	205	235	260	280	295	310	320	310	310	310
	5	11	13	12	13	13	12	7	7	6	6	5	6	4	4	4	5	4	3

TABLE 8

JUGTOWN LEFT PROFILE A AND C

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2501	130	125	120	115	110	110	110	120	130	215	245	270	290	305	320	325	320	315	315
2501	130	130	120	120	115	115	120	125	150	210	240	260	265	300	315	325	325	320	320
2501	130	130	120	120	120	120	120	130	150	220	255	280	295	310	320	325	320	320	320
2501	135	135	130	120	120	120	125	130	160	220	250	275	290	305	320	330	320	320	320
2501	140	140	130	125	120	120	120	130	150	215	245	270	290	305	320	330	325	320	320
2501	140	140	125	120	120	120	120	130	150	215	245	270	270	300	315	325	320	315	315
2501	135	130	135	125	120	120	120	120	130	210	250	270	290	305	325	335	325	320	320
2501	140	130	130	120	120	120	120	125	135	210	245	270	290	305	320	330	325	320	320
2501	140	135	135	130	130	130	130	135	150	220	250	270	295	310	325	330	325	320	320
2501	140	135	130	130	125	125	125	130	140	200	230	250	280	300	320	330	330	325	320
2501	140	140	140	135	130	130	130	135	155	210	250	270	290	300	320	330	320	320	315
2501	140	140	135	130	125	125	130	135	150	200	240	265	280	300	295	325	320	315	315
2501	140	135	135	130	125	125	125	135	150	210	250	280	300	320	335	345	340	335	335
2501	140	135	130	125	120	120	120	125	140	210	250	270	290	305	320	335	330	330	330
2501	140	140	130	125	125	120	125	130	160	220	250	270	290	310	325	330	325	320	320
2503	135	135	125	120	120	120	125	140	170	215	250	270	290	300	315	320	315	310	310
2503	125	135	130	120	120	120	125	130	160	210	245	270	290	300	315	325	320	320	315
2503	135	140	135	125	125	125	130	140	165	210	245	270	290	310	325	335	330	320	320
2503	130	135	130	120	120	120	125	140	170	210	250	270	290	300	315	320	315	310	310
2503	130	130	130	125	120	120	125	140	165	210	250	270	290	305	315	325	320	315	315
2503	135	135	130	120	120	125	130	140	170	210	245	270	285	300	315	320	315	310	310
2503	135	135	130	125	120	125	130	140	170	210	245	270	290	310	320	325	315	310	310
2503	130	130	130	125	120	120	120	130	150	200	240	260	290	295	310	325	315	310	310
2503	135	135	130	125	120	120	125	135	160	200	240	260	280	300	310	325	320	315	310
2503	135	140	135	125	125	125	130	140	170	205	240	270	285	300	320	325	320	315	310
2503	135	135	130	125	120	120	130	140	170	210	240	260	285	300	310	320	315	310	310
2503	135	135	130	125	120	120	125	130	155	200	235	260	280	295	310	320	310	310	310
2503	130	130	130	125	120	120	125	133	160	205	240	265	285	300	310	320	315	310	310
2503	130	135	130	120	120	12	125	135	160	200	235	260	280	295	310	320	315	310	310
2503	130	135	130	120	120	120	125	140	165	210	240	265	280	295	310	320	315	310	310
	5	13	11	10	11	14	8	6	4	9	10	11	9	8	6	6	5	5	3

TABLE 9

JUGTOWN RIGHT PROFILE B AND C

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1502	120	115	110	105	105	110	120	140	200	240	260	280	290	300	305	300	300	295	290
1502	125	120	115	110	110	115	120	135	200	230	250	275	290	300	300	305	300	295	290
1502	130	130	125	120	120	120	125	140	170	230	255	285	300	310	315	310	305	300	300
1502	120	120	115	110	110	110	115	125	155	210	240	260	280	295	305	310	305	300	300
1502	120	120	125	110	110	110	110	120	150	220	240	260	280	300	310	320	315	310	305
1502	130	130	120	115	115	120	120	135	170	225	250	270	285	300	305	310	300	300	300
1502	120	120	115	110	110	110	115	125	150	205	230	250	270	280	290	290	290	285	285
1502	115	110	100	095	095	095	100	110	130	190	220	245	260	270	280	290	285	280	280
1502	115	110	110	105	100	100	105	110	130	190	220	250	265	280	205	290	285	280	280
1502	120	120	115	110	105	105	105	115	130	185	220	245	265	285	295	300	290	290	290
1502	115	110	110	100	100	100	100	105	120	200	225	250	270	290	300	310	300	300	300
1502	115	110	105	100	100	100	100	110	130	200	235	260	280	290	300	300	295	290	290
1502	120	120	120	115	110	110	110	120	140	220	240	260	280	290	300	300	295	290	290
1502	115	110	110	105	100	100	100	110	130	195	220	245	260	280	290	300	295	290	290
1502	120	110	115	110	105	105	110	120	150	205	230	255	270	285	300	300	300	290	290
1503	135	135	130	120	120	120	125	140	170	210	240	270	285	300	310	320	320	315	310
1503	125	130	130	120	115	115	120	130	150	190	240	265	285	300	310	325	330	320	315
1503	135	135	130	120	120	120	125	130	150	210	240	270	290	310	320	335	330	325	320
1503	130	130	130	120	120	120	120	130	150	200	220	260	280	295	310	320	320	310	310
1503	130	130	130	120	120	120	120	130	150	200	235	260	280	300	310	325	320	320	315
1503	135	135	130	120	120	120	125	135	160	200	230	260	280	300	310	325	320	315	310
1503	135	130	130	125	120	120	125	140	160	210	210	265	205	300	315	320	315	310	310
1503	130	130	125	120	120	120	120	130	140	200	230	260	280	300	310	320	315	310	310
1503	135	135	130	120	120	120	125	135	160	205	235	265	280	300	310	320	320	315	310
1503	135	135	130	125	120	120	125	135	160	200	235	265	280	300	310	320	315	315	310
1503	135	135	130	120	120	120	120	130	150	190	225	250	270	290	305	320	320	310	310
1503	135	135	125	120	120	120	120	130	160	200	230	260	280	295	305	320	310	310	310
1503	130	130	130	120	120	120	125	135	160	205	240	265	280	295	305	315	310	310	310
1503	130	130	130	120	120	120	125	135	155	200	230	260	290	290	305	320	310	310	310
1503	130	130	120	115	115	115	120	130	155	205	235	260	280	295	310	320	310	310	310
	2	2	3	2	2	4	4	4	9	9	11	12	9	8	5	1	1	1	0

TABLE 10

JUGTOWN LEFT PROFILE B AND C

RAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2502	120	120	110	105	100	105	110	120	150	220	245	265	280	295	300	305	300	295	290
2502	125	125	120	115	110	110	110	120	150	210	245	260	280	290	300	305	305	295	290
2502	130	130	125	120	120	120	125	135	160	210	250	270	290	300	310	310	305	300	300
2502	120	125	120	110	110	115	120	130	160	210	245	265	280	300	310	310	305	300	300
2502	120	120	115	110	110	110	110	120	150	220	240	260	280	300	310	320	310	310	310
2502	130	130	130	125	120	120	125	135	165	210	245	265	290	295	305	305	300	300	300
2502	120	125	120	115	115	115	120	130	150	200	235	255	270	285	290	300	290	285	285
2502	115	120	110	105	105	105	110	120	150	200	235	255	270	285	290	290	285	280	280
2502	115	120	110	100	100	100	105	110	140	205	230	250	260	275	285	290	285	280	280
2502	120	120	120	110	110	110	110	120	140	200	230	255	275	290	300	300	295	290	290
2502	115	120	120	110	105	105	105	110	130	210	240	260	285	300	305	310	300	300	300
2502	115	120	115	110	105	105	105	110	130	190	225	250	270	285	300	300	295	290	290
2502	120	120	115	110	105	105	110	120	150	220	245	260	280	290	300	300	300	290	290
2502	115	110	110	105	105	105	110	125	160	215	245	265	280	290	300	300	295	290	290
2502	120	120	115	105	105	105	110	120	150	210	240	255	275	290	300	300	295	290	290
2503	135	135	125	120	120	120	125	140	170	215	250	270	290	300	315	320	315	310	310
2503	125	135	130	120	120	120	125	130	160	210	245	270	290	300	315	325	320	320	315
2503	135	140	135	125	125	125	130	140	165	210	245	270	290	310	325	335	330	320	320
2503	130	135	130	120	120	120	125	140	170	210	250	270	290	300	315	320	315	310	310
2503	130	130	130	125	120	120	125	140	165	210	250	270	290	305	315	325	320	315	315
2503	135	135	130	120	120	125	130	140	170	210	245	270	285	300	315	320	315	310	310
2503	135	135	130	125	120	125	130	140	170	210	245	270	290	310	320	325	315	310	310
2503	130	130	130	125	120	120	120	130	150	200	240	250	280	295	310	325	315	310	310
2503	135	135	130	125	120	120	125	135	160	200	240	260	280	300	310	325	320	315	310
2503	135	140	135	125	125	125	130	140	170	205	240	270	285	300	320	325	320	315	310
2503	135	135	130	125	120	120	130	140	170	210	245	260	295	300	310	320	315	310	310
2503	135	135	130	125	120	120	125	130	155	200	235	260	280	295	310	320	310	310	310
2503	130	130	130	125	120	120	125	135	160	205	240	265	285	300	310	320	315	310	310
2503	130	135	130	120	120	120	125	135	160	200	235	260	280	295	310	320	315	310	310
2503	130	135	130	120	120	120	125	140	165	210	240	265	280	295	310	320	315	310	310
	2	2	2	2	2	2	3	5	7	12	15	8	7	8	0	0	1	1	1

TABLE 11

SUM OF AUTHORSHIP SCORES FOR
THE PAIRWISE COMPARISONS

Pairwise Comparison	Sum of Authorship Scores
A and B (R)	69
A and B (L)	78
A and C (R)	140
A and C (L)	144
B and C (R)	89
B and C (L)	80

Table 11 demonstrates that Potter B is the most distinct because the lowest authorship scores are associated with each of his comparisons. By way of contrast, the comparisons of Potter A with C show much higher authorship scores. These two potters show the greatest overlap, or are least distinct, though an examination of the authorship scores for the individual rays in their comparisons, tables 7 and 8, shows that several rays are clear indicators of idiosyncratic differences. If the profiles of Potter B are used as a constant against which to measure the distinctness of Potters A and C, it appears that Potter A is slightly more distinct than Potter C. Potter A's authorship scores with Potter B are just a little lower than those of Potter C.

This interpretation of the authorship scores bears some relationship to other ethnographic factors at Jugtown. Potter B, who is the most distinct producer in the experiment, has been working at the commune for only a short time. He began his apprenticeship about five months prior to the experiment. It seems that he has not quite mastered the Jugtown template for this particular vessel form. Potters A and C are both experienced ceramicists, each with over 15 years of experience in pottery manufacture. Both have been at the workshop for more than four years, and their frequent overlap reflects their greater familiarity with the Jugtown template for this vessel form.

Potter C, the least distinct of all the potters, is the only full time specialist in the test. He is also the acknowledged craftsman of the workshop. Because of this, Potter B served as his apprentice. Interestingly, Potter B shows closer affinities with Potter C, his master craftsman, than he does with Potter A. Potter A is only a part time ceramicist, as much of her time is taken with the administrative affairs of the workshop.

It seems that this type of analysis can easily designate individual producers despite the close overall similarity of the artifacts. This analysis was also capable of delineating more subtle ethnographic factors at the workshop. An examination of the prehistoric material revealed that the authorship scores are much higher than those discussed in the Jugtown analysis (see appendix A). Therefore, it becomes more difficult to interpret the prehistoric material with the same confidence shown in the interpretation of the Jugtown sample. Another mode of analysis is needed to obtain a finer grained resoltuion to this problem.

Principal Components Analysis (PCA) as an Analytic Technique in Idiosyncratic Studies

Gunn (1972) tried a variety of analytic techniques to determine which mode of analysis would best separate authors of the artifacts. Each of the techniques tested designated individual artisans, though

Discriminant Function provided the best separation.[1] He did find, however, that Principal Components Analysis (PCA) could distinguish one producer from another. Similar distinctions using PCA were also achieved by White and Thomas in their study of the Aluni materials which was presented in chapter II. It was decided to retest the Jugtown and prehistoric materials using PCA to determine if any improvement could be made in the designation of individual craftsmen.

The PCA for this study was implemented using the SPSS program PA 1 (Nie et al 1975).[2] This program was implemented on the XDS Sigma 7 computer at Queens College. These programs resulted in a set of loadings on each of the original variables for each of the components, the percentage of variation assumed by each component, and a set of scores for each case reflecting how each case behaves within and contributes to the variance assumed by each component. The loadings on each of the original variables indicate which variables contribute most significantly to the component. These variables can then be attributed to specific areas along the vessel profile, similar to the authorship scores. Therefore, there is no loss of information as to which part of the vessel profiles are sensitive indicators of individual differences.

The scores represent the way in which a case contributes to the variation assumed by a particular component. This score is determined by the case's raw data multiplied by the loadings on the original variables for the component. Thus, those variables which contribute

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[1] At the time these tests were made, Discriminant Function was not operational at Queens College.

[2] All built-in default values were used except for the number of components, which was set to 3.

most significantly to the new component are most important in determining the scores for a particular case. These results are presented in a score matrix, in which every case has a score for each component produced by the analysis.[1] These scores are then used to plot each of the cases in two dimensional space using the components as axes, as described in chapter II.[2]

The use of PCA has certain other advantages aside from its proven ability to designate individual craftsmen. First, the use of scores in a two dimensional plot lessens ". . . the distortional effect inherent in any portrayal of the data in fewer than the original number of dimensions" (McCammon and Wenninger 1970:2). Second, the components produced by the analysis represent composite variables which are independent of one another. Covariance is subsumed under the same component, and these components can be assigned descriptive labels by referring to the loadings, as described above.

Third, the scores, when plotted on two dimensional graphs, provide a measure of product uniformity according to producer. If in a plot the points of a producer are more widely scattered along one axis than another, this variation can be interpreted according to the descriptive label assigned to the component. For example, figure 67 shows that the points are widely scattered along the vertical axis and narrowly distributed along the horizontal axis. In this example the vertical axis represents a component for which there are high loadings on the base of the pot and the horizontal axis represents the rim of

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[1]See Harris (1975) for complete and lucid description of this technique.

[2]I am grateful to Nick Detsis, who wrote the plotting routine.

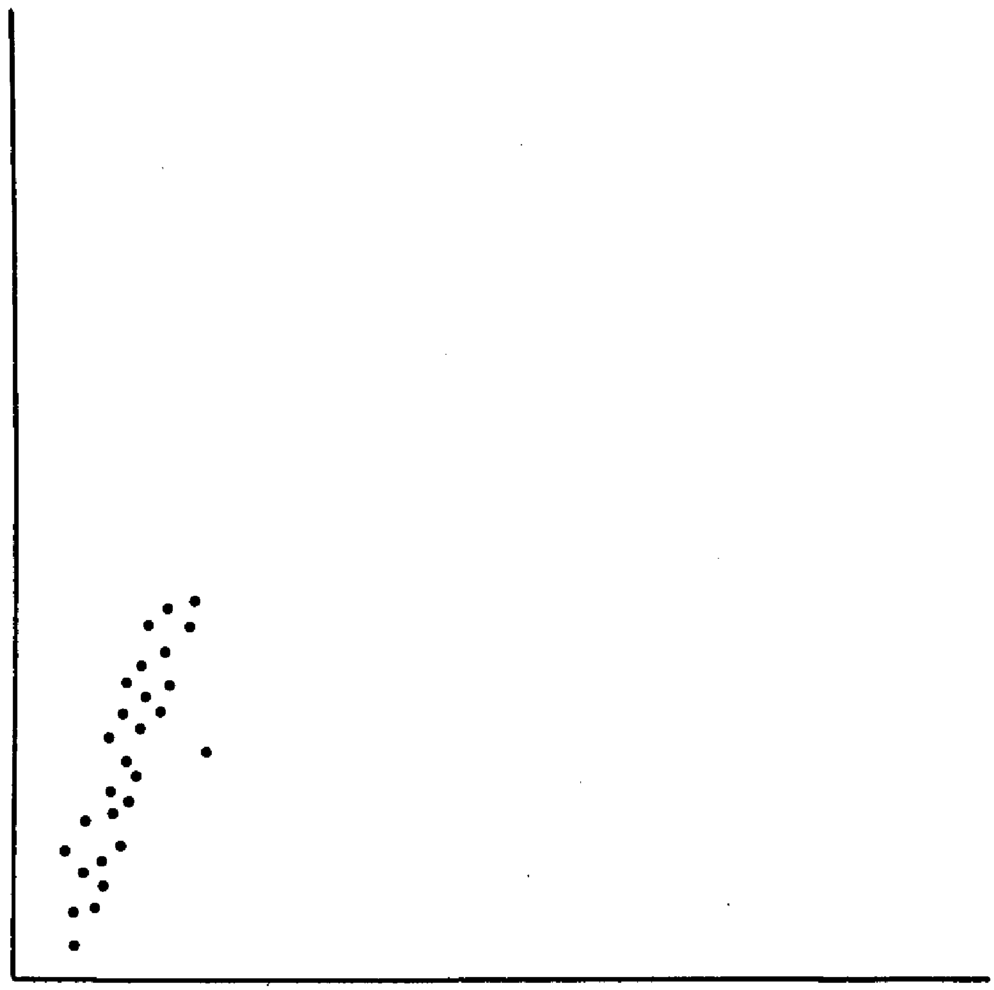


Fig. 67. Hypothetical Principal Components Plot.

the vessel. It can be interpreted from the figure that the particular manufacturer had greater variation in the base of his pot as compared to the rim. Comparisons can also be made between individuals to determine who has greater variability in the manufacture of their artifacts by determining which potter has a wider scatter of points.

Fourth, it is also possible to determine if there is any relationship between the two components by analyzing the distribution of the points. Figure 67 shows that there is some direct relationship between the component represented by the horizontal axis and the component represented by the vertical axis. Thus, it becomes possible to understand the relationships which might exist between different areas of the vessel profile.

Idiosyncratic Patterning and Distinctness among the Jugtown Potters Using PCA

The results of the PCA were most interesting. In the six comparisons tested, the first three components accounted for more than 79.5% of all the variation within the sample of profiles. The percentage of variation assumed by each component is shown in table 12, and the loadings for each of the original variables in all the pairwise comparisons represented in appendix B. The plots, using the scores for each case, are presented in figures 68-79. These plots only show Components 1 with 2 and 1 with 3 (Component 1 is the horizontal axis in all plots) because they are the best designators of individual craftsmen.

An inspection of the plots demonstrates that PCA can designate the authorship of the profiles by establishing groups of points which

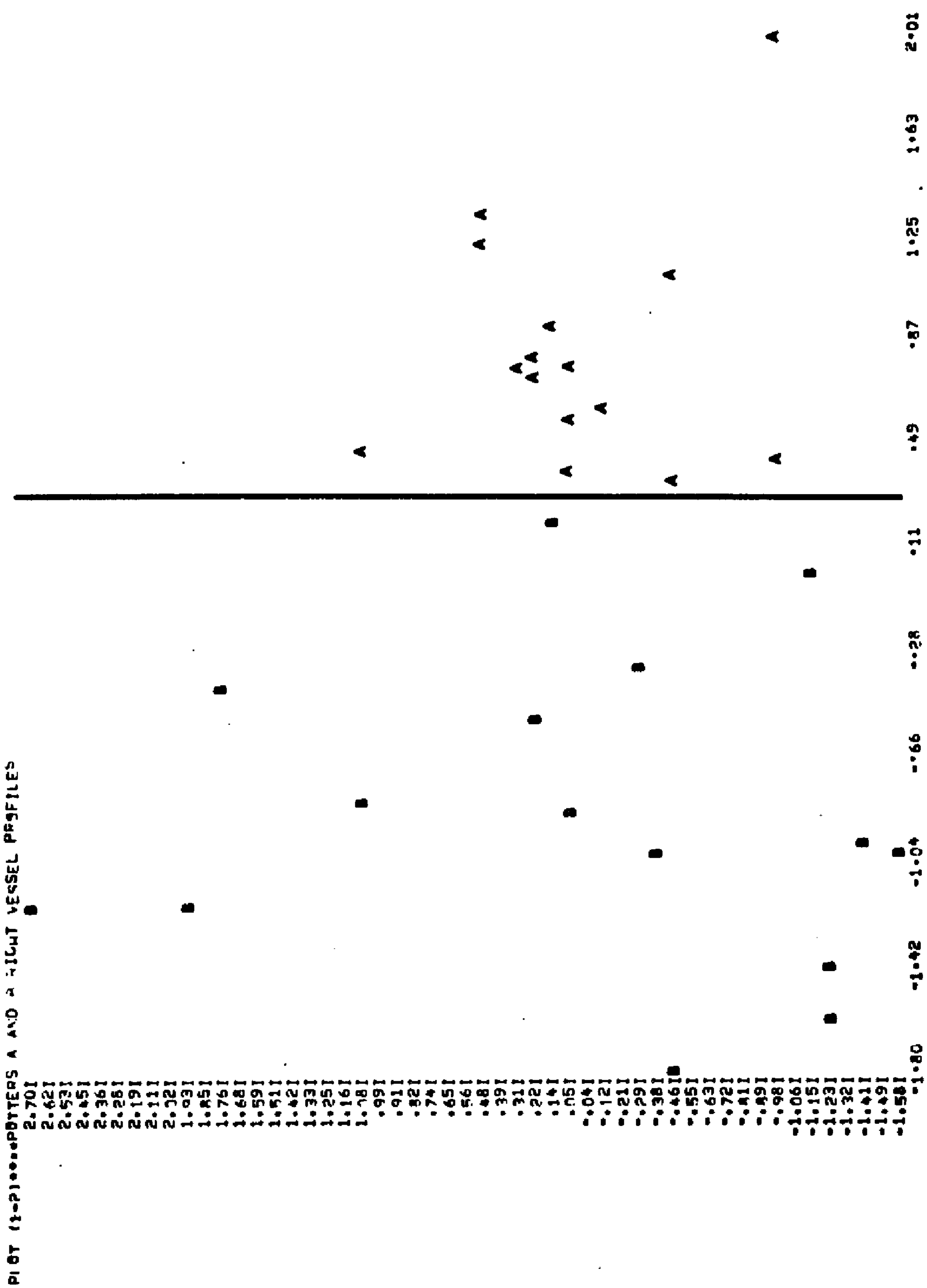


Fig. 68.

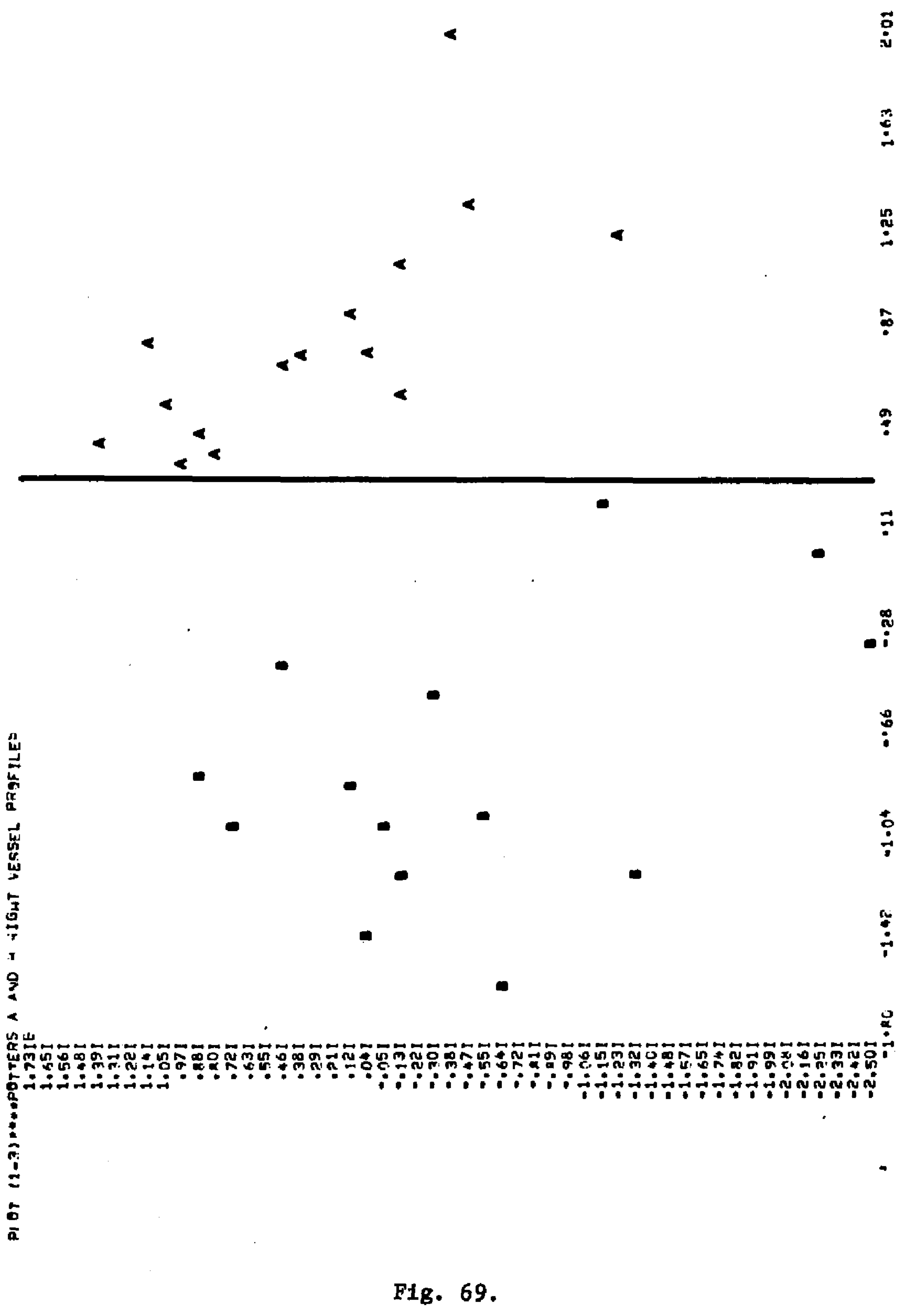
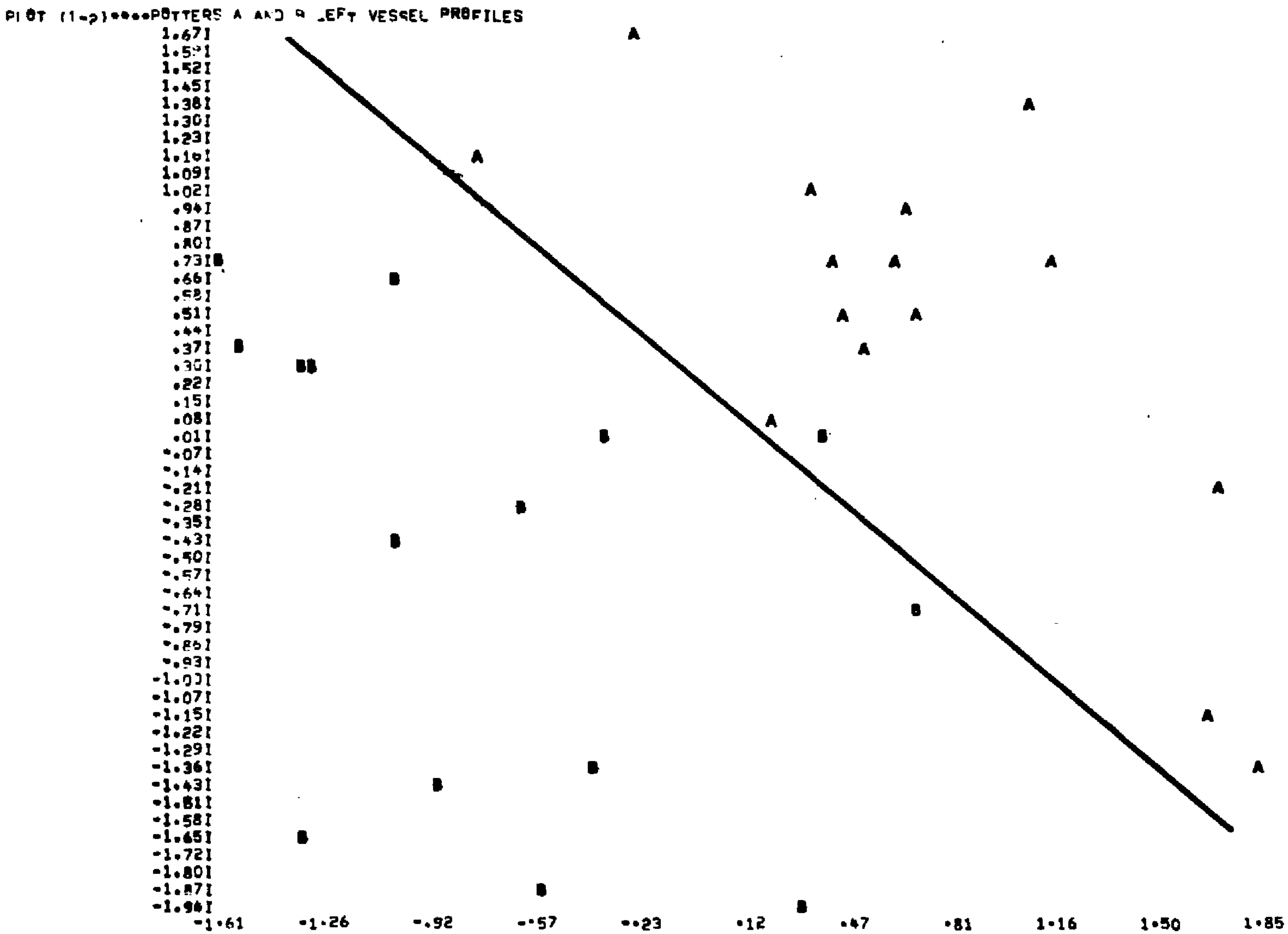


Fig. 69.



PLOT (1-2)****POTTERS A AND B LEFT VESSEL PROFILES
1.67
1.59
1.52
1.45
1.38
1.30
1.23
1.16
1.09
1.02
.94
.87
.80
.73
.66
.58
.51
.44
.37
.30
.22
.15
.08
.01
-.07
-.14
-.21
-.28
-.35
-.43
-.50
-.57
-.64
-.71
-.79
-.86
-.93
-1.00
-1.07
-1.15
-1.22
-1.29
-1.36
-1.43
-1.51
-1.58
-1.65
-1.72
-1.80
-1.87
-1.94
-1.61
-1.26
-.92
-.57
-.23
.12
.47
.81
1.16
1.50
1.85

Fig. 70.

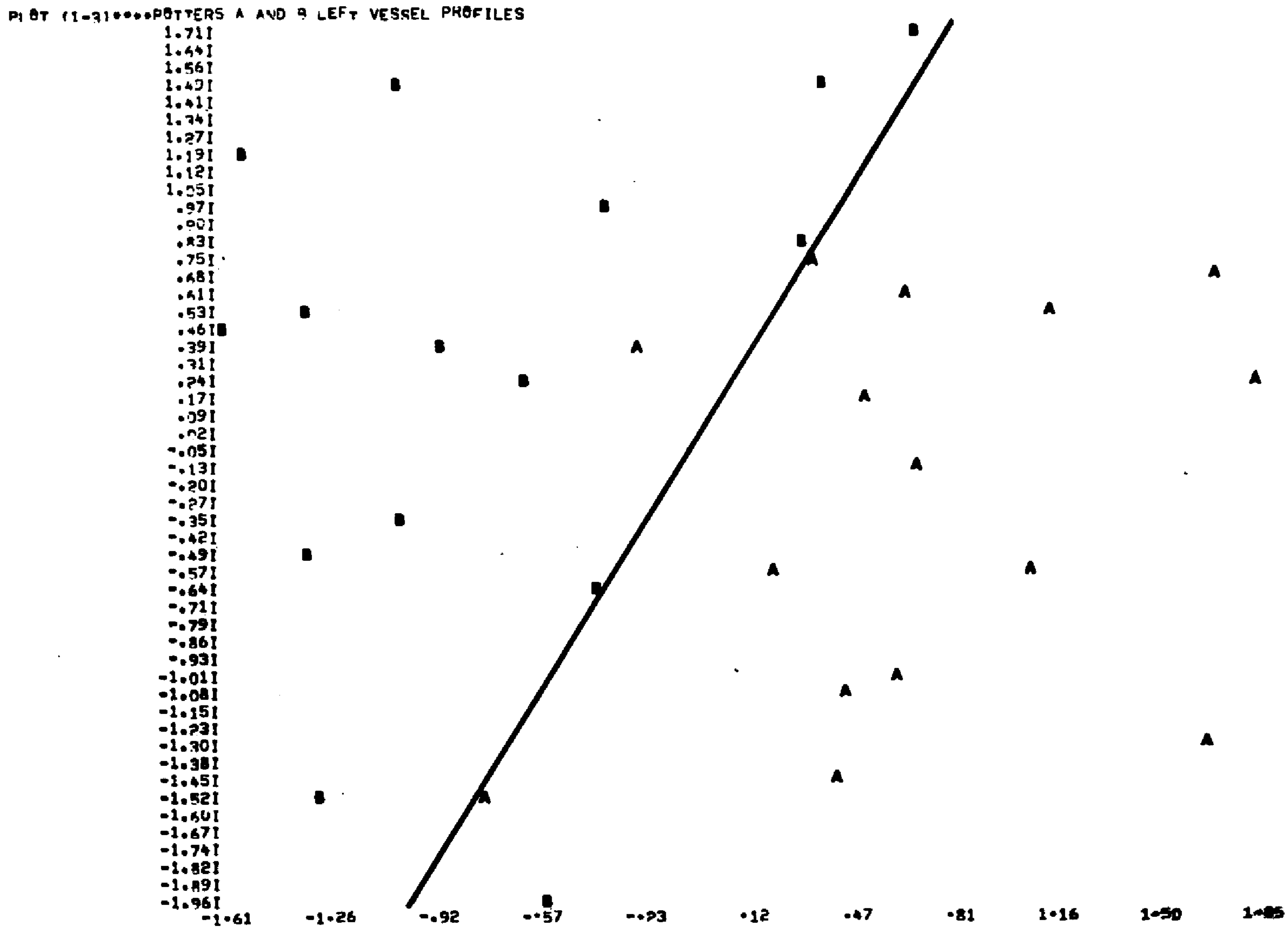

PLOT (1-3)****POTTERS A AND B LEFT VESSEL PROFILES
1.71 1.64 1.56 1.49 1.41 1.34 1.27 1.19 1.12 1.05 .97 .90 .83 .75 .68 .61 .53 .46 .39 .31 .24 .17 .09 .02 -.05 -.13 -.20 -.27 -.35 -.42 -.49 -.57 -.64 -.71 -.79 -.86 -.93 -1.01 -1.08 -1.15 -1.23 -1.30 -1.38 -1.45 -1.52 -1.60 -1.67 -1.74 -1.82 -1.89 -1.96
-1.61 -1.26 -.92 -.57 -.23 .12 .47 .81 1.16 1.50 1.85

Fig. 71.

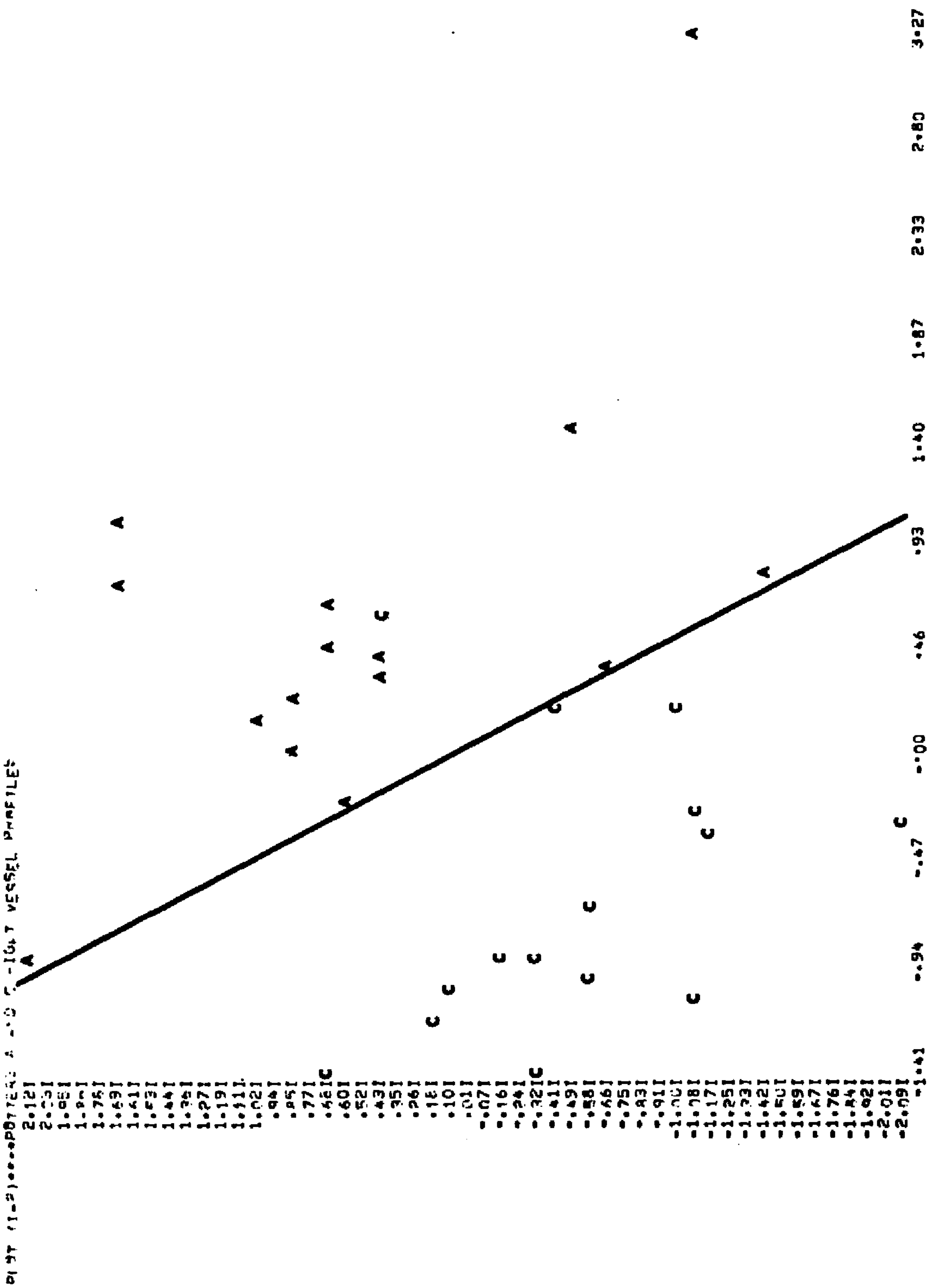


Fig. 72.

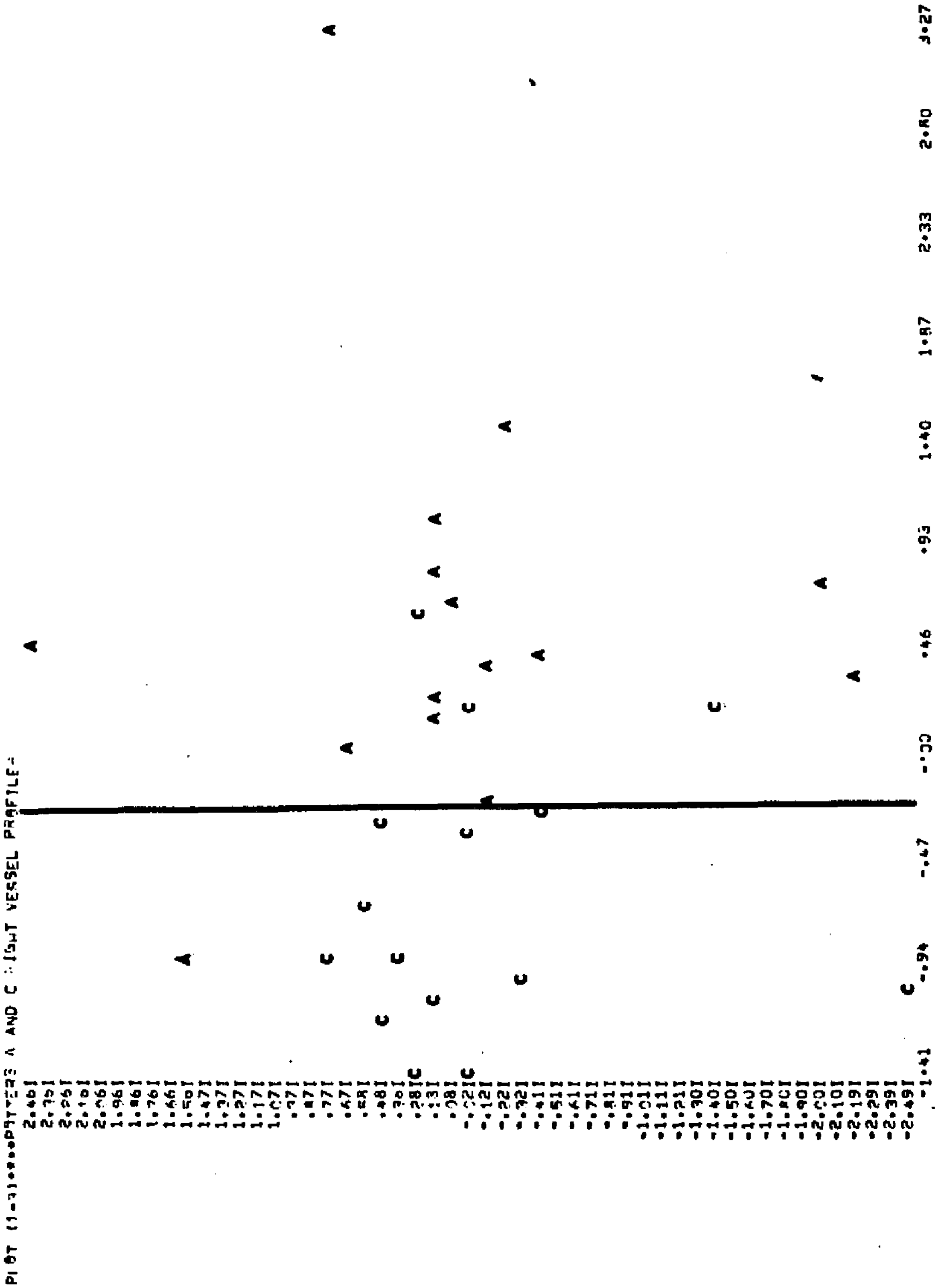


Fig. 73.

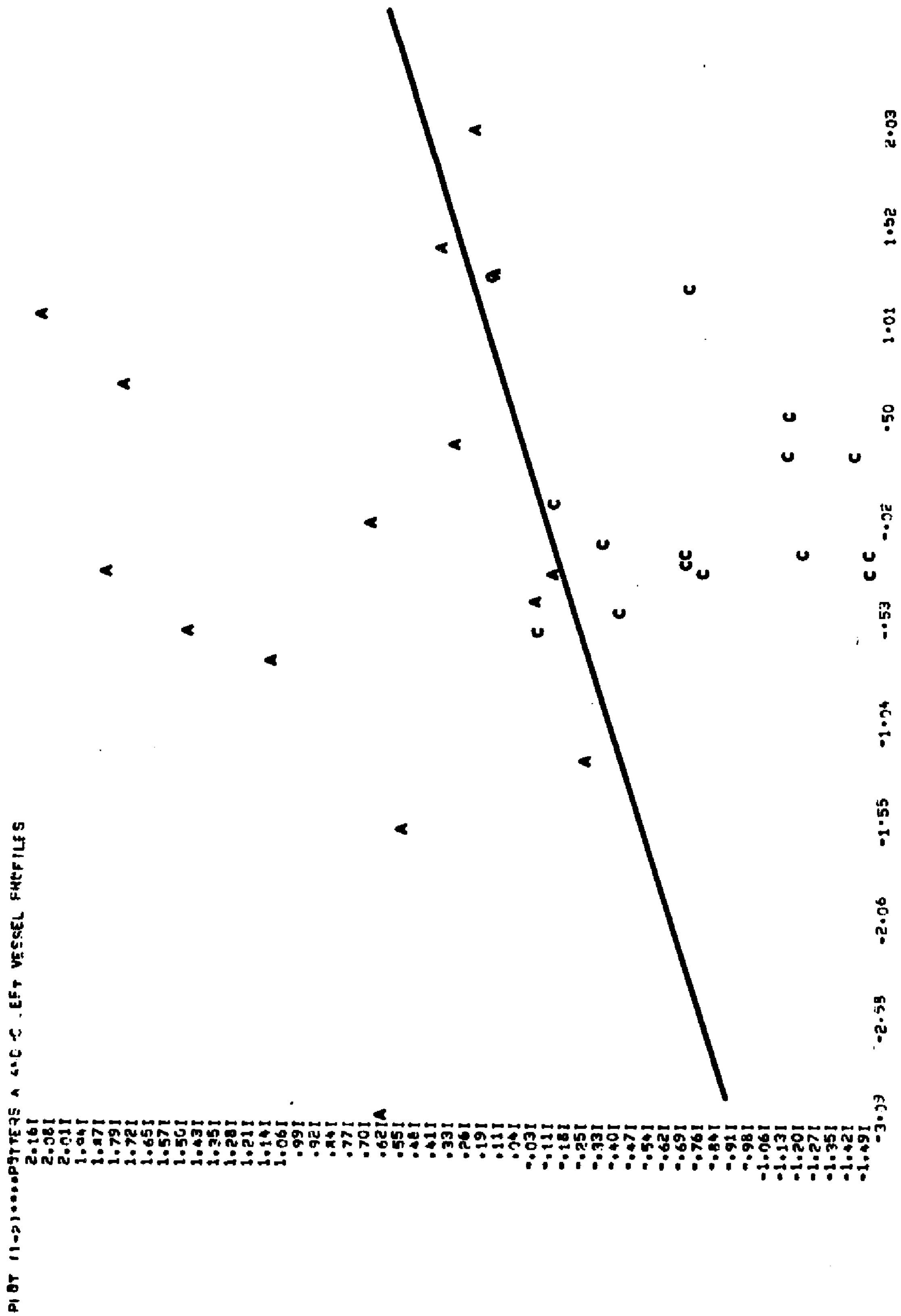


Fig. 74.

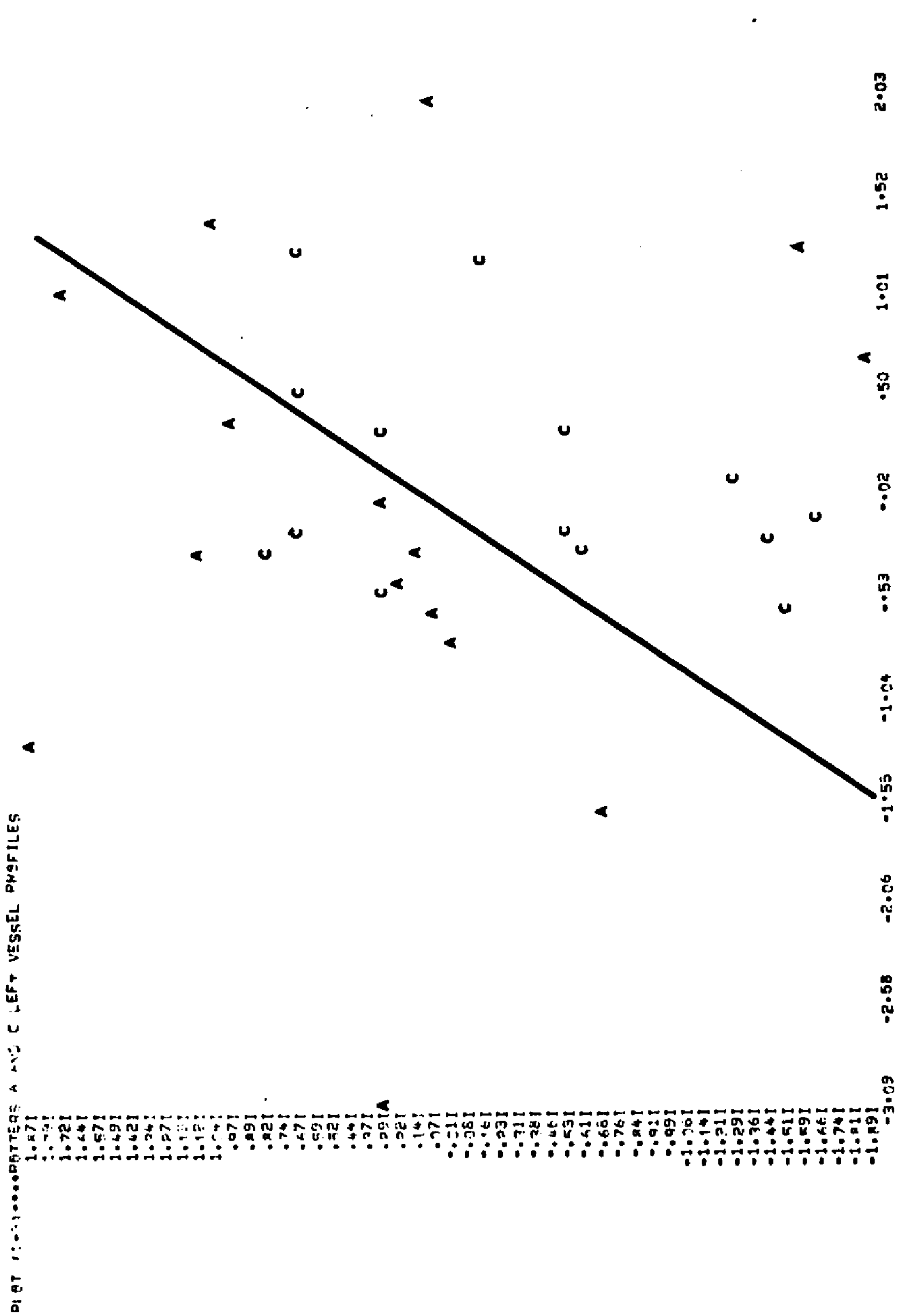


Fig. 75.

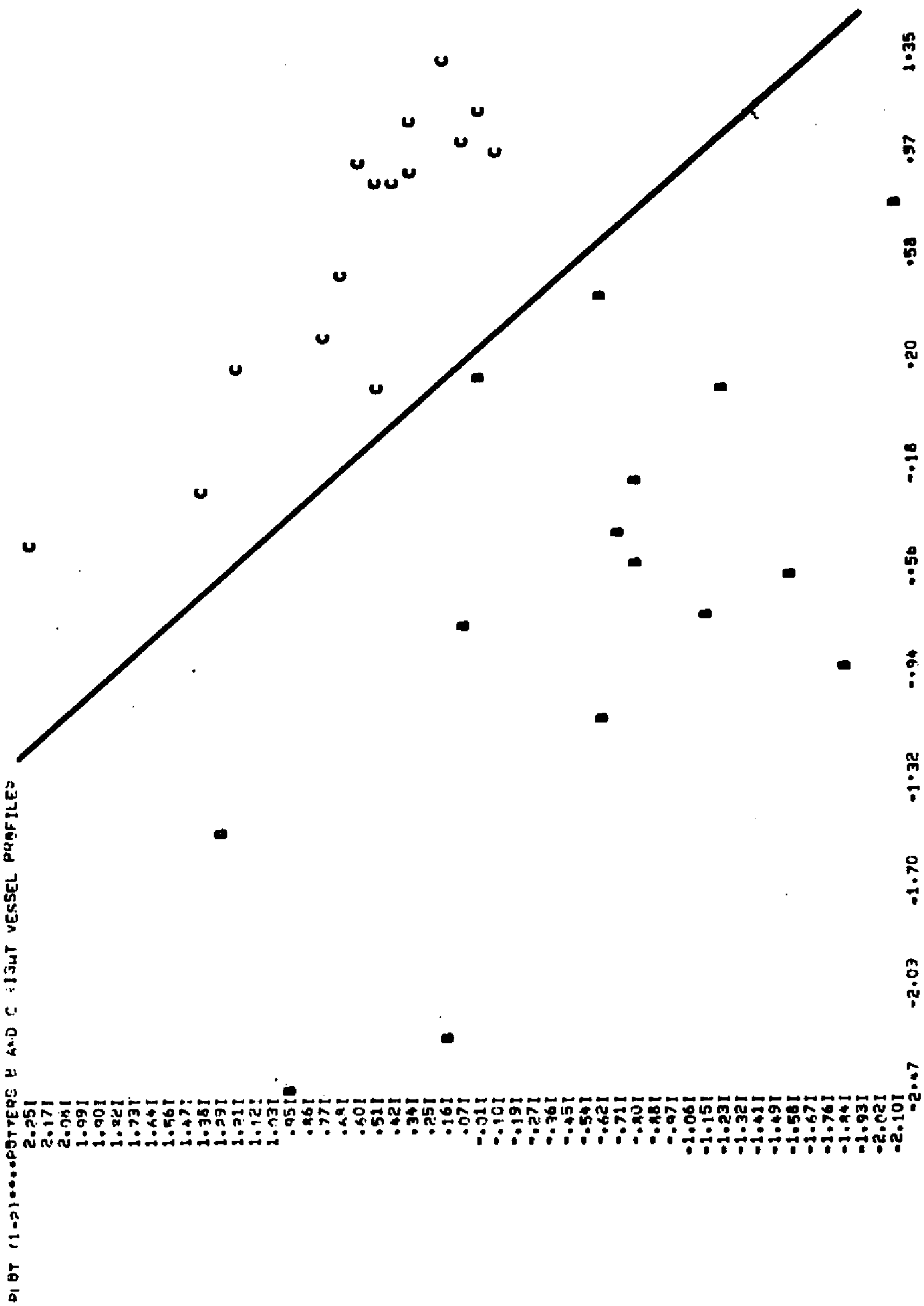


Fig. 76.

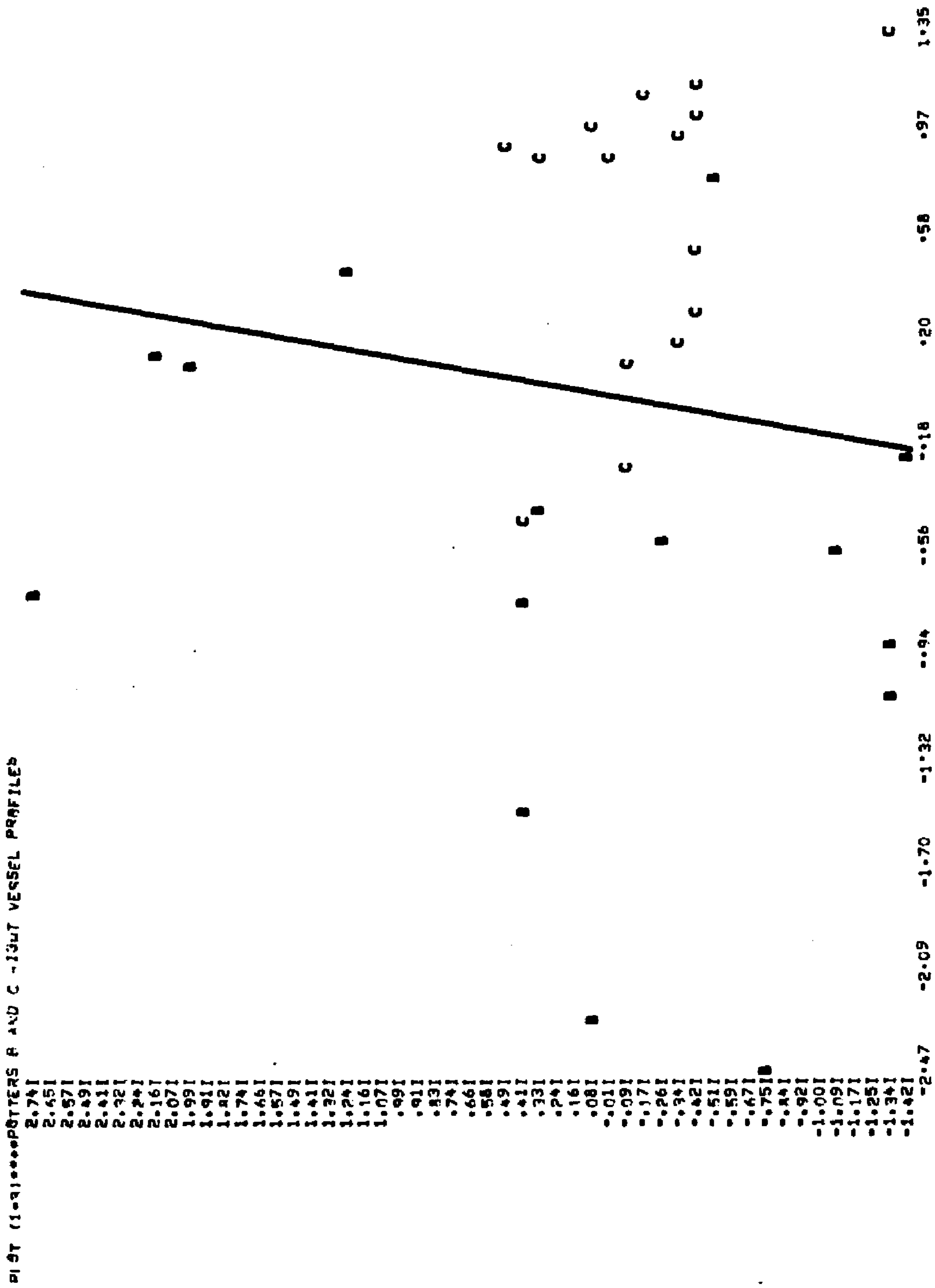


Fig. 77.

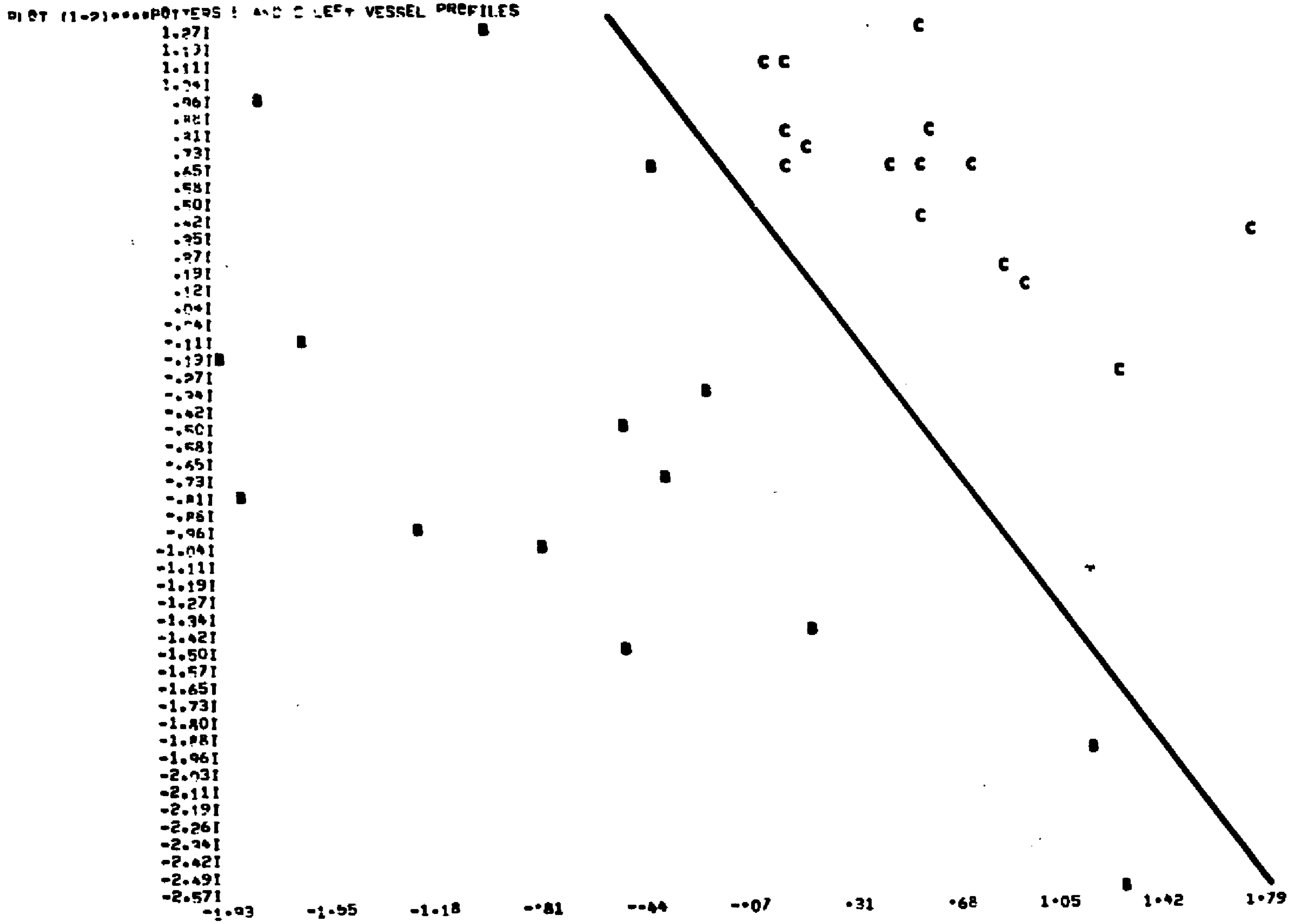

PLOT (1-2)****POTTERS B AND C LEFT VESSEL PROFILES
-1.93
-1.55
-1.18
-.81
-.44
-.07
.31
.68
1.05
1.42
1.79

Fig. 78.

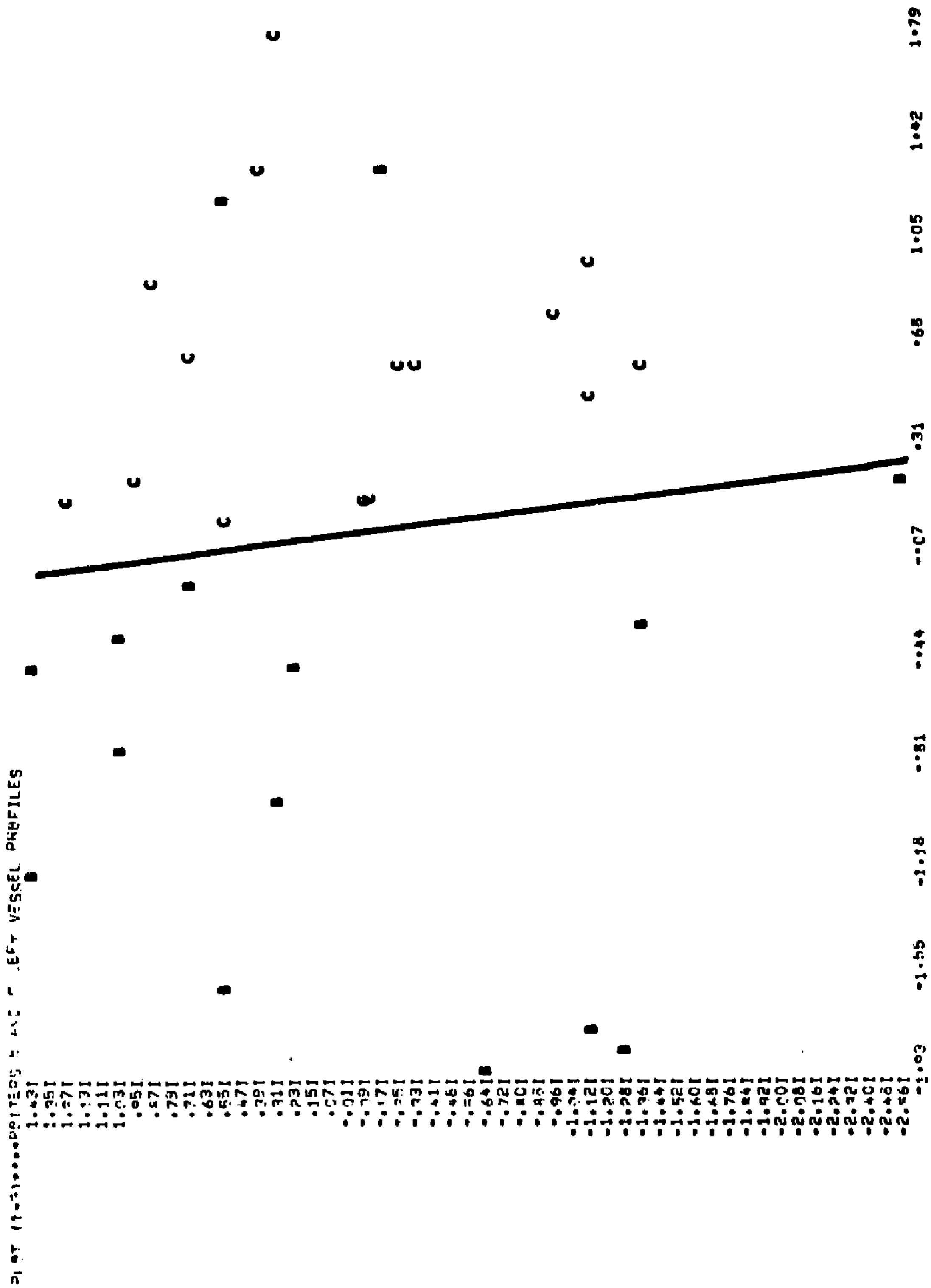


Fig. 79.

are either entirely homogeneous or nearly so. These groups are determined by drawing a straight line amongst the points which best separate the two craftsmen. Though not computed for this study, it is quite possible to determine the slope for each of these lines.

TABLE 12

PERCENTAGE OF VARIATION ASSUMED BY EACH COMPONENT IN THE PAIRWISE COMPARISONS

Comparison	Component 1	Component 2	Component 3	Sum of First Three Components
A and B (R)	75.0	16.0	9.8	94.8
A and B (L)	70.9	11.5	9.8	92.2
A and C (R)	46.8	22.6	10.2	79.5
A and C (L)	39.4	27.4	14.7	81.5
B and C (R)	69.5	19.5	5.7	94.7
B and C (L)	73.7	12.8	5.9	92.5

In some instances, for example figure 68, a line perpendicular to the horizontal axis separates one potter from the other. This indicates that the set of profiles by Potter A is consistently larger for the variables subsumed under Component 1. Other plots, for example figure 19, show an oblique line as the best separator. In this case, the separating line shows an inverse relationship between the two components.

The main objecive of the reanalysis of the Jugtown material was to determine if any improvement could be made in the designation of individual craftsmen, using PCA. This can best be accomplished by examining the plots of those comparisons which had the highest authorship scores, Potters A and C, both Right and Left profiles. It is important to remember that high authorship scores reflect less distinctness.

Therefore, any improvement in the distinctness between these two potters would provide a meaningful measure of the PCA's usefulness to designate authors. The plots of these two potters are shown in figures 72 through 75.

The plots indicate that significant improvement is made in the designation of individual craftsmen. In the comparison of Right profiles, only one profile is located within the grouping of the other potter when the scores for Components 1 and 2 are used (figure 72). This represents a better separation of potters than the lowest authorship score for this same comparison (table 7), which shows three profiles in the range of the other potter. The lowest authorship score reflects the separation developed by only one ray, whereas the PCA plots incorporate composite variables which include most of the vessel profile. The number of non-distinct profiles increases to four when the scores for Components 1 and 3 are plotted (figure 73).

In the comparison of left profiles from Potters A and C, improvement is also observed. When the scores for Components 1 and 2 are plotted (figure 74), the number of non-distinct profiles is two. This represents some improvement over the lowest authorship score of 3 (table 8). The number of incorrectly located profiles increases to seven when the scores for Components 1 and 3 are used (figure 74). The number of non-distinct profiles is generally lower for the comparisons involving Potter B with either Potters A or C than the previously discussed plots. This was expected because the authorship scores for any of the comparisons involving Potter B were much lower than the authorship scores for the comparisons of Potters A and C. Table 13 summarizes the information regarding the number of profiles of one potter in the cluster established by the other potter. This table, when compared to the authorship scores (tables 5-10), shows that improvement is made when PCA is used. This improvement is in large measure caused by the two dimensional display of the variability in the sample of profiles. The authorship scores display the variability in only one dimension.

TABLE 13

NUMBER OF PROFILES IN THE CLUSTER OF THE OTHER POTTER

Comparison	Components 1 and 2	Components 1 and 3	Components 2 and 3
A and B (R)	0	0	10
A and B (L)	1	2	5
A and C (R)	1	4	5
A and C (L)	3	8	1
B and C (R)	0	4	4
B and C (L)	0	2	4
	5	20	29

NOTE: The total number of profiles for each comparison is 30 (15 from each potter).

An examination of the plots and the summary of the number of overlapping profiles (table 13) reaffirms the conclusions drawn about "other ethnographic factors at Jugtown". Potter B emerges as the most distinct and Potter C the least distinct. Potters A and C have the most overlap, which I believe is caused by their greater familiarity with the Jugtown template. Potter B again shows greater overlap with Potter C, with whom he has worked as an apprentice.

It is possible to draw some other conclusions from these plots as they relate to product uniformity and relationships which exist between certain areas of the vessel profile. There appears to be a direct relationship between skill and product uniformity. Potter C, the most skilled and active potter in the experiment, has the tightest cluster of points in all the comparisons. His points are tightly clustered when compared to the other potters. Potter A comes out as the second most uniform. Her points are more widely distributed in her comparisons with Potter C, but tighter in her comparisons with Potter B. Potter B, the least skilled potter in the test, had his profiles widely scattered in all his comparisons. Interestingly, despite the wide scattering of his points, his profiles are still clearly distinct from those of the other potters.

Interpretations can also be made about the product uniformity of a potter along the axes representing the components. In figure 78, it appears that Potter A has a narrower range of variation along the vertical axis than she does along the horizontal axis. In this discussion, I am using some notion of general tendency, minimizing the extreme cases. Potter B, on the other hand, does not show any tight cluster of points and has a wider distribution of points along the vertical axis than the horizontal one. Similar interpretations can be made for the other comparisons.

The plots also permit statements to be made about the relationships which might exist between the components for a particular potter. In figure 70, there seems to be an inverse relationship between Factors 1 and 3 for Potter A. As the size of the variables represented by Component 1 increases, the size of the variables represented by Component 3 decreases. Similar observations can be made in the other comparisons.

The PCA, in conjunction with table 12, reveals one other important fact. There appears to be a direct relationship between the percentage of variation assumed by the components used in the plots and their ability to designate authorship of the profiles. The total number of incorrectly placed profiles is significantly smaller when Components 1 and 2 are used as compared to Components 1 and 3. In the set of plots using Components 1 and 2, only five profiles are non-distinct. The total number of profiles in the cluster of the other potter increases significantly to 20 when Components 1 and 3 are used and 29 non-distinct profiles when Components 2 and 3 are considered. No plot using Components 1 and 3 shows fewer non-distinct profiles than the plots incorporating Components 1 and 2, though significant clustering by potter is shown in all plots. Previously it was mentioned that the percentage of variation assumed by each component decreases as the component number gets higher. Component 1 assumes the greatest percentage of variation in the test, Component 2 the second highest, and so on. Therefore, the plots utilizing Components 1 and 2 account for the greatest percentage of variation in the sample. Plots utilizing Components 1 and 3 encompass a smaller percentage of the variation and Components 2 and 3 even less. An examination of table 12 shows that with one exception (A and B (R)), there is an appreciable difference in the percentage of varation assumed by Components 2 and 3. Therefore, there is a significant difference in the percentage of variation assumed by Components 1 and 2 as compared to Components 1 and 3.

Further support for the direct relationship between percentage of variation assumed by the components and its sensitivity to distinguish authors has already been described. It was decided not to provide the plots of Components 2 and 3 because they were poor discriminators of individual potters. The variation assumed by these two components is much less than any of the previously mentioned combinations (see table 10 for percentage of variation associated with each component). My reworking of the White and Thomas data also shows similar findings. There are a greater number of non-distinctive tests associated with the plots using Components 1 and 3 as compared to the plots using Components 1 and 2 (see table 2 in chapter II of this dissertation). It can be concluded that in sets of artifacts produced by people who share a template, a significant percentage of the variation within the assemblage reflects distinct differences between producers. The percentage of variation is considered to be significant because the first two components account for more than 69% of the variation in the Jugtown study and more than 80% in the Aluni study conducted by White and Thomas (1972). Much of the remaining variation is non-distinctive and can be considered noise because it cannot be used to effectively designate individual producers. PCA is ably equipped to report and use this information because it ranks the components according to percentage of variation they assume and plots the cases, providing a measure of idiosyncratic distinctness. This analytic technique is, then, appropriate for a retesting of the prehistoric material.

CHAPTER IV

ANALYSIS OF DIVOSTIN CERAMICS

Cultural Context

Before a presentation of the Divostin analysis can begin, it is both necessary and important to sketch the general cultural picture during the Neolithic of central Jugoslavia. This will provide a backdrop for the Divostin assemblage. The Neolithic of Jugoslavia begins during the middle of the sixth millenium B.C. The sequence of early farming cultures for central Jugoslavia has been divided into two different and sequent traditions: Starcevo and Vinca. Starcevo is part of a very widespread early farming complex which extends into the neightboring countries of Hungary, Rumania, and Bulgaria. Essentially similar artifact inventories in these countries are designated by different names. The diversity in nomenclature is not justified on typological grounds but reflects the different historical developments in archaeology within each of these countries and certain nationalistic tendencies. Starcevo and its allied cultures begin approximately 5400 B.C. and continue until 4200 B.C. (dates are uncalibrated). They occupy the Early Neolithic for this region.

The Starcevo complex is characterized by a mixed economy reflecting utilization of domesticated plants and animals with some reliance upon hunting. Thre is little in the way of any evidence to suggest that wild plants were part of the subsistence pattern. The degree of dependence upon each of these food sources has recently been discussed by Murray (1970). In her investigations of faunal and floral evidence, she found that bones from undomesticated animals, mostly red and roe deer, may have constituted as much as 20% of the animal bone recovered from the sites. Domesticated animals included cattle, ovicaprids, pigs, and dogs. Of these, ovicaprids are the more important domesticated forms. Einkorn, emmer and barley have been identified as domesticates at several of the sites.

Starcevo house types, as Markotic (1962:15) has stated: "space is an old and controversial question." Some 15 years later, the question is no closer to resolution. The controversy centers upon the function of large, irregularly shaped pits which sometimes contain fire pits. Many Jugoslav archaeologists interpet these depressions as the remains of semi-subterranean dwellings. Others point to the presence of clearly developed house floors, sometimes in association with the pits, as the remains of small, rectangular, above ground dwellings. They conclude that the above ground dwellings precludes the use of pits as houses. The pits, they argue, may result from the extraction of clay or dirt for use in the wattle and daub house construction. Later, the pits may have been used for a variety of purposes, including refuse dumps and animal pens. Neither of the house forms show any evidence for internal divisions to form rooms.

Settlements belonging to the Starcevo complex for the most part do not show the accumulation of great amounts of midden debris. Indications are that the occupations of the sites were short term. The strong reliance upon ovicaprids and their propensity to overgraze may be a contributing factor to this short term occupation. The increased movement of the settlements may be seen as a contributing factor for the broad area distribution of Starcevo and its allied cultures in neighboring countries. The cultural homogeneity of this Early Neolithic culture may have also been caused by its rapid spread into specific ecological zones. Tringham (1971) has noted the strong correlation between these early farming sites and loess soil. Thus, the resulting pattern appears to have been periodic but frequent movement of settlements within a narrow range of soil zones.

Marked local differences in the material culture of the Balkans does not begin to appear until the Middle Neolithic, which marks the beginnings of the Vinca Culture in central Jugoslavia. The Vinca complex achieved prominent recognition as a result of the excavations by Vasic in the early 1900s. The site is impressive with over ten meters of archaeological deposits, part of which span the entire Neolithic sequence. The intensive excavations provided a wealth of material from which the standard Vinca chronology has been established. Some refinements of this basic sequence have been made in the years following Vasic's excavations. Materials recovered from the sites of Tordos in Rumania and Plocnik in Jugoslavia, as well as several reanalyses of the original Vinca materials, have served as the basis for these refinements (see Markotic 1962:92-98 for a brief historical overview of the development of Vinca chronology). The Vinca sequence, according to recent sets of Carbon 14 dates, spans 1000 years, from 4200 B.C. to 3200 B.C. This corresponds to the Middle and Late Neolithic of central Jugoslavia. The Middle Neolithic (4200-3800 B.C.)

refers to either Vinca A and B or Vinca Tordos. Vinca C and D or Vinca Plocnik refers to the Late Neolithic (3800-3200 B.C.). Though some problems in chronology remain, particularly on the local level, a standard sequence for the areas has been firmly established.

The Vinca culture is distinguished from the Starcevo complex by a number of elements, especially ceramics. Starcevo decorated pieces are either painted, rusticated, or impressed. Vinca ceramics, on the other hand, are grey to black in coloration and grit or grog tempered. Decoration is in the form of complex channeled and incised patterns. Paints are not used on ceramic vessels. Numerous differences are also noted in vessel forms.

Aside from changes in ceramics, Vinca sites also show several other important distinguishing characteristics. Analyses of animal bones indicates a dramatic shift in the use of domestic animals. Though each of the major classes of domestic animals continues in use, cattle now replace ovicaprids as the most dominant form (Murray 1970). The significance of this shift is demonstrated when the weight of usable meat from each animal type is considered. Cattle provide approximately ten times more usable meat than ovicaprids (Flannery 1968:82). The significance of hunting increases somewhat during the Middle and Late Neolithic. Wheat and barley are still the predominant domesticated plants.

Midden material from Vinca occupations is generally richer and thicker than Starcevo middens. This is the result of two factors: size of the settlement and length of occupation. Vinca settlements are considerably larger than Starcevo. The latter usually consist of six to ten houses and the former fifteen to twenty-five. Not only are the number of houses greater in Vinca settlements, but the house size is considerably larger. Vinca houses are from eight to sixteen meters long and five to six meters wide, whereas Starcevo houses are approximately six by four meters. The larger and more numerous houses indicate a larger population for Vinca settlements, resulting in more midden materials. Since the larger population and number of houses is spread out over a proportionally larger area (unspecified ratio), the greater thickness and richness of Vinca midden deposits cannot be attributed to the increase in population alone. Therefore, longer periods of occupation for each settlement appears to be a contributing factor to the accumulation of debris.

An examination of the architecture also seems to indicate longer periods of occupation for Vinca settlements than Starcevo. The houses, especially during the Late Neolithic, have two or three rooms, each with their own hearth. Hearths, as large as three square meters, are well constructed. They are a meter deep, with alternating layers of dirt and broken sherds covered with a refractory mortar. The substantial nature of the structure and the split log floors are further evidence for the "permanency" of the structure. At the site of Kormadin, two large, almost life size, clay models of cattle heads were found amongst the ruins of a burned house. The heads may have been attached to the gable ends of the houses. These architectural features provide substantial evidence for the relative permanency of Vinca occupations.

Metal objects make their first appearance during the Middle Neolithic and increase in frequency through the Late Neolithic. Early centers for metallurgy have been identified to the east of the Vinca culture (Renfrew 1968), but Jovanovic (1971) and Jovanovic and Ottoway (1976) have reported the use of copper mines in central Jugoslavia at the site of Rudnik as early as Late Vinca B or Late Vinca Tordos. Scattered findings of metal objects in Vinca contexts have previously been interpreted as coming from outside regions, though some evidence for smelting in Jugoslavia has recently been summarized by Jovanovic and Ottoway (1976). If their determinations are correct, the earlier assumptions about metallurgy in central Jugoslavia will need reevaluation. Tringham (1971) has outlined a number of other changes between Starcevo and Vinca in stone and bone tools.

Description of Site: Chronological and Spatial Referents

The prehistoric material used in this study was recovered from the Late Neolithic level at the site of Divostin, Jugoslavia. The site is located about 90 kms due south of Beograd and 7 kms west of the modern city of Kragujevac (see figure 80). The site is named after the small hamlet which covers part of the site. Most of the site surface, however, is farmed. Fortunately, the contemporary farmers are using ox or horse drawn plows which do not penetrate deeply into the soil. Thus the house floors, located about one meter or less below the surface, were undisturbed by the farming activities.

Divostin has been dated using Carbon 14, uncorrected and uncalibrated, to a time period between 4000 to 3300 B.C. on the basis of five determinations which form two groups: one at 3900 B.C. and the other at 3300 B.C. (McPherron and Srejovic 1971). These dates do not reflect the duration of occupation at the site, but as yet some unexplained variation in either the material provided for dating or lab-

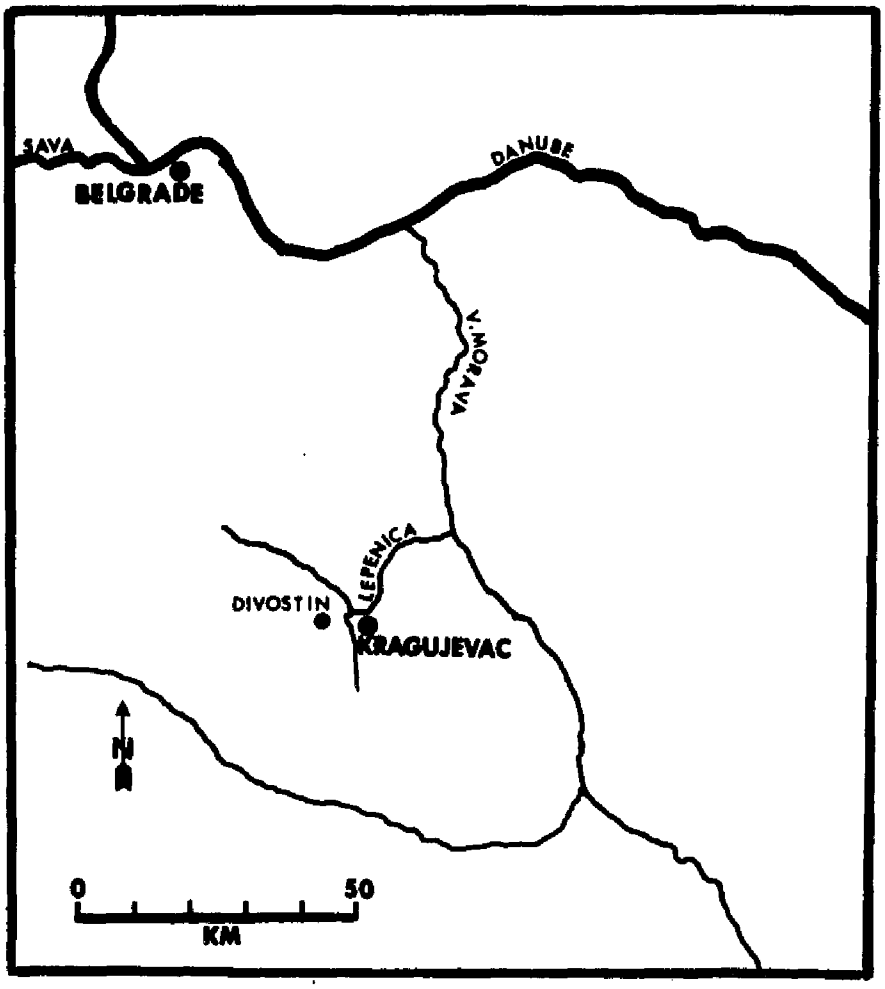


Fig. 80. Map of the Area Surrounding Divostin.

oratory procedures as shown by one charcoal sample. This sample was divided in half and sent to different laboratories. The resulting dates, BM 574 (3300 B.C.) and Bln 898 (3910 B.C.), illustrate the variation in dates. The archaeological evidence from a variety of sources strongly suggests a short term occupation of the site, terminated by a fire which consumed the entire village.

The artifacts found at the site show a general cultural affiliation with the Late Neolithic culture of Serbia. Stylistically, the ceramics specifically belong to the later sub-phases of the Vinca-Plocnik or Vinca D phases of the sequence for this area. Cross dating of the Divostin material with other sites possessing less variable dates and well-defined stratigraphy suggests that the more recent cluster of dates at 3300 B.C. represents the actual occupation in radiocarbon years (McPherron and Srejovic 1971).

Broad scale horizontal excavations were initiated at the site under the directon of Professors A. McPherron and D. Srejovic. These excavations revealed the remains of at least eight house floors. These house floors represent the units to be used in the pairwise comparisons for the evaluation of idiosyncratic patterning in this Neolithic context. These houses are located on figure 91 and are identified by the following feature labels: (1) House 19, (2) House 21, (3) House 89, (4) House 90, (5) House 91, (6) House 99, (7) House 100, and (8) House D. These feature labels are those used in the field and found in the preliminary publication (McPherron and Srejovic 1971).[1]

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[1]The new numbering system is: (1) House 19 = Feature 12, (2) House 21 = Feature 13, (3) House 89 = Feature 14, (4) House 90 = Feature 15, (5) House 91 = Feature 16, (6) House 99 = Feature 17,

Certain conditions were outlined in chapter II which had to be met before the artifacts and units of comparison could be tested for idiosyncratic patterning. They included temporal, functional, status and ethnic differences amongst the artifacts or units of comparison which could potentially influence the results of the tests discussed below. If these variables can be controlled, the remaining variation in the sample could be attributed to differences resulting from the pattern of production: household or specialized.

Contemporaneity of Units of Comparison and Artifacts

Each of the houses, with the exception of House D, was burned in what appeared to be a simultaneous event. The ceramics in all the burned houses are stylistically similar to one another in both decoration and vessel form (McPherron and Srejovic 1971). The strong similarity of the ceramics within each of the burned houses and the widespread occurrence of burning at almost all Vinca sites in this area (McPherron and Srejovic 1971, Milojcic 1948, and Tringham 1971) spanning different sub-phases of the Vinca-Plocnik sequence suggests that the houses within each site were burned simultaneously. Therefore, the burned houses at each of the sites and the artifacts within them are contemporaneous with one another. The artifacts, however, are contemporaneous relative to their moment of production. DeBoer (1972), David and Hennig (1970), and Foster (1960) have shown that pottery vessels have different rates of longevity within a single household. Vessels belonging to the same type are often separated by

(7) House 100 = Feature 18, and (8) House D = Feature 10. Bogdonovic (1976) has identified several other questionable Vinca house floors at the site.

four of five years in age. Thus, the artifacts within the burned houses can be considered to be somewhat contemporaneous. They are probably not the result of the same production event and therefore can be considered to have accumulated over a "short" time period.

The burned houses provided a wealth of ceramic material which was recovered directly from the house floors. The collapse of the house structures during the fire broke the vessels which remained. However, the sherds which constituted any one vessel were generally located in close proximity to one another, often revealing the shape of the vessels. Therefore, it was easy to identify complete vessles on the house floors and subsequently reconstruct them. To this point, 267 vessels have been identified on the house floors from six of the houses (see figure 81 for site map).

These pots have been divided into 17 different vessel types based on shape and the type of appendage, if any, located on the profile, such as a spout or handle. The various vessel forms identified at the site are shown in figure 82 and their frequency within each of the houses is shown in table 14. Additional ceramic material was found in the form of sherds scattered on the house floors. These sherds could not be attributed to any specific vessel. These sherds were present within the houses at the time of burning because they show the orange to red color which is characteristic of the refired ceramic.[1] Though

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[1]The normal color of Vinca pottery is grey to black or variegated black-grey. The fire which burned the houses created an oxidizing atmosphere which changed the color of all the ceramics in the houses from grey-black to orange-red. This made it possible to distinguish and eliminate pottery found on the house floors which resulted from activities subsequent to the burning of the houses, such as erosion or plowing.

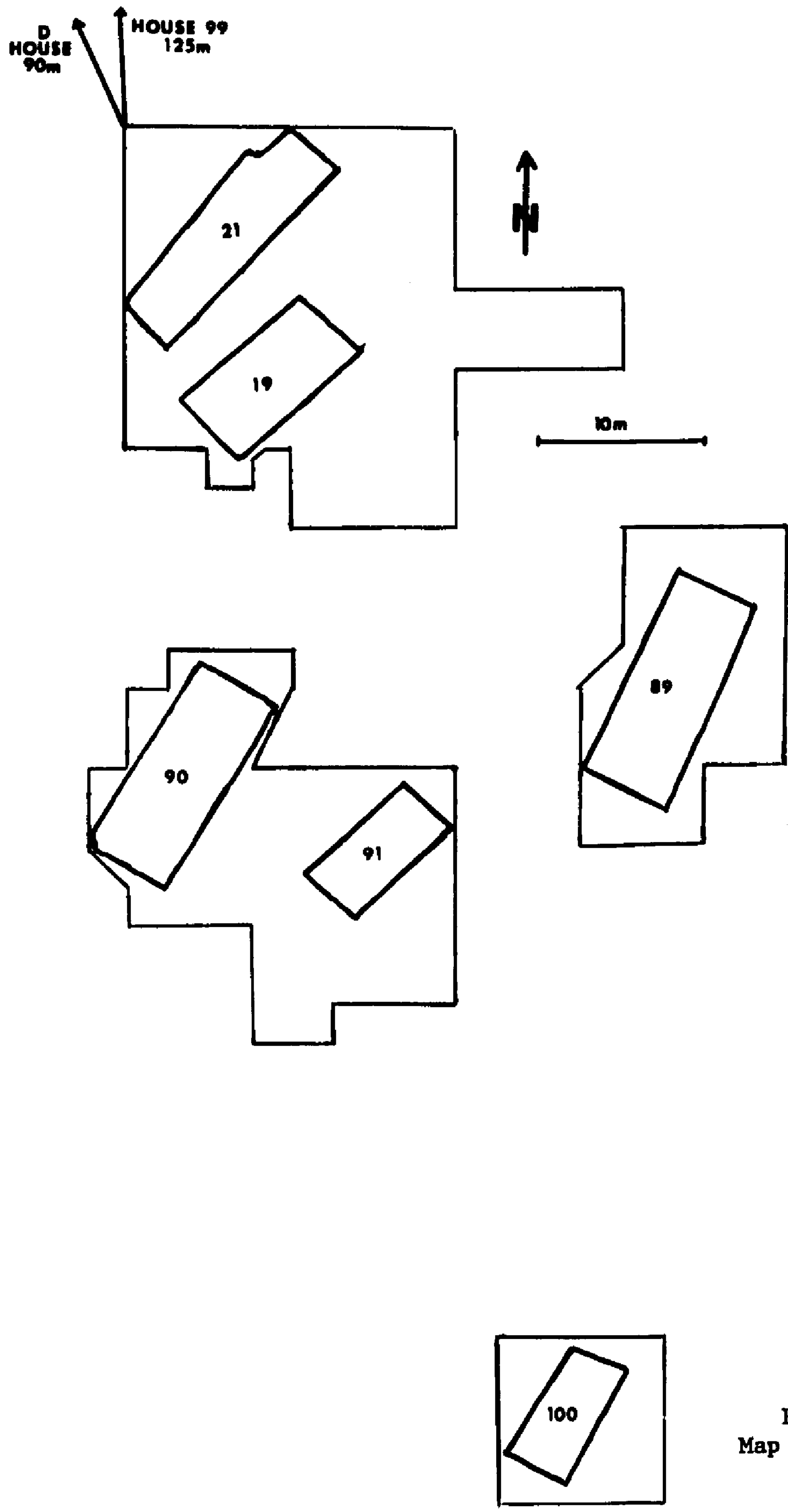

Fig. 81. Site Map of Divostin.

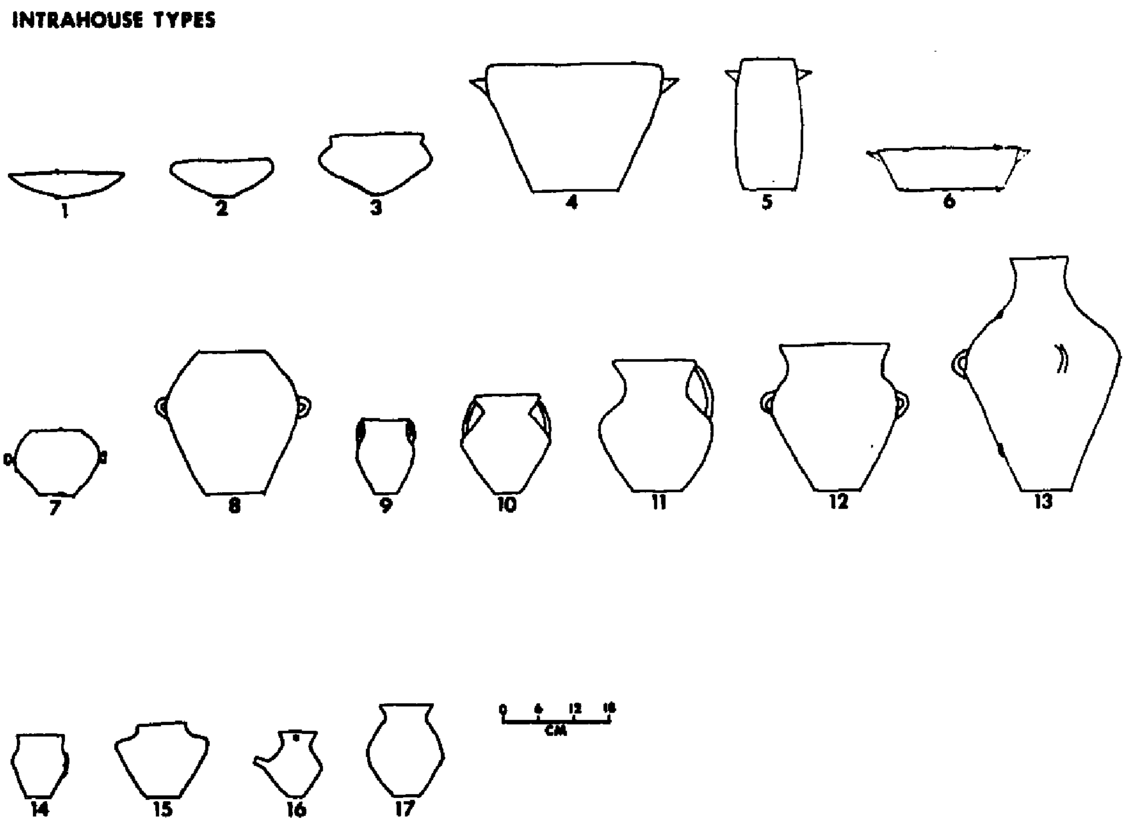

Fig. 82.

TABLE 14

FREQUENCY DISTRIBUTION OF CERAMIC VESSELS ON BURNED HOUSE FLOORS

Vessel Form	House 21		House 89		House 90		House 91		House 99		House 100		Sum of Vessels	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	-	-	1	1.4	-	-	-	-	-	-	1	1.7	2	0.8
2	10	25.6	14	19.2	8	14.3	3	17.7	5	21.8	18	30.5	58	21.7
3	7	20.0	11	15.1	9	16.1	5	29.4	5	21.8	13	22.0	50	18.7
4	1	2.6	4	5.4	2	3.6	1	5.9	2	8.7	3	5.1	13	4.9
5	-	-	1	1.4	-	-	-	-	-	-	1	1.7	2	0.8
6	-	-	2	2.7	-	-	1	5.9	1	4.4	-	-	4	1.5
7	1	2.6	-	-	-	-	-	-	-	-	-	-	1	0.0
8	-	-	-	-	1	1.8	-	-	-	-	-	-	1	0.0
9	-	-	1	1.4	-	-	-	-	1	4.4	-	-	2	0.8
10	-	-	-	-	4	7.2	-	-	-	-	-	-	4	1.6
11	1	2.6	2	2.7	1	1.8	1	5.9	1	4.4	1	1.7	7	2.6
12	13	33.3	24	32.9	18	32.1	3	17.7	4	17.4	10	17.0	72	27.0
13	-	-	1	1.4	3	5.4	-	-	-	-	-	-	4	1.5
14	-	-	-	-	1	1.8	-	-	-	-	-	-	1	0.0
15	-	-	1	1.4	-	-	-	-	-	-	1	1.7	2	0.8
16	1	2.6	-	-	-	-	-	-	2	8.7	1	1.7	4	1.5
17	5	12.8	11	15.1	9	16.1	3	17.7	2	8.7	10	17.0	40	15.0
Totals	39		73		56		17		23		59		267	

counts were not kept of these isolated sherds, my impression is that they were not frequent. This suggests that the houses were relatively "clean" at the time of burning. If the houses were littered with the remains of many refired sherds which could not be attributed to any particular vessel, it might reflect the accumulation of debris over a period of time. Therefore, the pots and sherds within the houses at the time of burning are the result of recent ceramic production. The "clean" houses make the material used in the analysis more contemporaneous than one might initially expect.

The analysis of idiosyncratic patterning rests upon the use of the only two bowl forms recognized at the site, vessel types 2 and 3. These forms represent the second and third most frequently encountered vessel forms on the house floors, comprising 21.6% and 18.7% of the sample (see table 14 for the percentage of each vessel type within the houses).[1] These bowl forms, however, are most frequently encountered in the midden material comprising respectively 38.4% and 26.3% of all the rim sherds. The increase in their frequency outside of the houses indicates that the lifespan of these vessels is not great and shorter than the lifespan of the other vessel forms. This is in agreement with some of the studies on ceramic longevity which show that bowl forms have shorter lifespans than other vessel types (David and Hennig 1972 and DeBoer 1974). Therefore, if the lifepsan of these bowls is short, as compared to other vessel forms, then the sample used in the test is the result of production events not spaced too widely in time.

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[1]The most frequent vessel form, Type 12, was not used because vessel profiles were too incomplete to permit testing. The large number of

The use of complete vessels recovered from the house floors, isolated sherds from these same "clean" floors, and vessel forms which show high breakage rates indicating a relatively short life span suggests that the profiles used in this study can be considered contemporaneous.

Functional Equivalence of Houses

The functional equivalence of the houses must be established before they can be compared for patterning of idiosyncratic variation. The fire which consumed the site and provided the excellent sub-assemblage of ceramic vessels was not as kind to other types of materials. The fire in the houses was extremely intense. Experiments conducted by Mary Ivey (1970) attempted to replicate the conditions which produced the melted and vitrified pottery. Her experiments indicated that the pottery melted at a minimum temperature of 1900 degrees Fahrenheit. The fire in the houses probably exceeded this minimum temperature. These extremely high temperatures destroyed much of the other types of evidence presumably left inside the houses. Materials aside from ceramics were infrequently recovered from the house floors. The recovery of these other materials was further compromised by the lack of screening and flotation procedures. The sporadic recovery of these materials from the houses makes them unsuited for the discussion of functional equivalence of households. The evidence to be examined includes structural features of the houses and the ceramic evidence including pottery and loom weights.

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sherds which constituted any one vessel precluded reconstruction in most cases.

An examination of table 14 shows that the four vessel forms, Types 2, 3, 12, and 17 (defined as the core group), comprise 82.1% of all the vessels identified on the house floors. These four vessel forms account for approximately equivalent cumulative percentages within each of the houses (see table 15). The essentially similar ceramic inventories within each of the houses suggests that similar activities were occurring within them. In other words, the vessel inventories indicate that the houses were functionally equivalent.

TABLE 15

NUMBER OF FIRE HEARTHS AND PERCENTAGE OF CORE VESSELS IN EACH HOUSE

Houses	Number of Hearths	Number of Core Vessels	Total Number of Vessels	Percentage of Core Vessels
21	2	35	39	89.7
89	4	50	73	68.5
90	3	44	56	78.6
91	1	14	17	82.4
99	2	16	23	69.6
100	0*	51	59	86.4

*This house, according to Bogdanovic (1976), has two shallow depressions which may have functioned as hearths.

There does appear, however, to be significant variation in the number of pots within the houses. They range from 17 to 73. The difference in the number of pots does appear to be related to the number of hearths within the house. Only two houses do not fall into the expected pattern, Houses 99 and 100. House 100 does not have any definite hearths but, according to Bogdanovic (1976), two shallow depressions were located in the house which appear to have functioned as hearths. These depressions occur in areas where hearths are found in the other houses. If these two depressions are accepted as hearths, then only one house does not follow the general pattern. Importantly, the percentage of core pots within each of the houses does not vary considerably despite the considerable variation in the number of vessels. Therefore, the function of each house, as indicated by the ceramic vessels, does not seem different.

One other class of ceramic objects, loom weights, also suggests that the houses were functionally equivalent. These loom weights were found in each burned house, suggesting that looming was an activity associated with each of the households.

The spatial distrubtion of these ceramic artifacts on the house floors revealed no patterning with the exception of House 89. In this house, a storage area is indicated by the presence of numerous large vessels positioned near a fire hearth. This storage area was separated from the rest of the house by a low wall approximately one meter high. In another part of the house, bowls were positioned around another fire hearth.

The gross architectural features of the houses also point towards similarity in function for each of the houses (Bogdonovic 1976). The houses are all fairly large, ranging in size from five to six meters in width to nine to sixteen meters in length. Analysis of the fired wattle and daub indicates that the walls of the houses were constructed in a similar manner. Floor constrution and foundations for the houses are also similar in each case. This would seem to indicate similar functions for each of the houses.

One major difference is found in the number of fire hearths in each house. These range from zero to four. The variation in the number of hearths within each of the houses is as yet unexplained, but perhaps may be related to the number of people and organization of activities carried out in various parts of the house. The differences in the number of hearths does not, however, seem to indicate that entirely different activities took place within the houses. The available evidence concerning the hearths is too inconclusive. It appears, then, from the data available, that the houses are functionally equivalent, fulfilling one of the other conditions outlined in chapter II. Therefore, differences in the number and types of vessels are not the result of radically different functions between houses.

Status and Ethnic Differences

Two other variables must be controled before the analysis of idiosyncratic variation can proceed. The control of these variables at the site is most difficult. While undoubtedly status differences did exist at the site, there is little in the way of evidence to suggest that any of the houses included in the analysis reflect different status levels. The similarity of basic ceramic inventories and the strong similarity in ceramic decoration found within each of the houses eliminates this as one possible measure of status differences. House shapes and construction also point to similar status levels for each of the households and their occupants. The likelihood of ethnic differences amongst the people represented by these households is also diminished by the similarities cited above.

The strongest argument for the control of these variables rests with the results of the analysis itself. As will be shown in the following section of this chapter, the general pattern of ceramic production for each of these bowl forms is household. Unless the position is taken that each of these houses received slightly different ceramics, reflecting their different ethnic or status backgrounds, the pattern is clearly household. Different status or ethnic positions in the village, if they did exist within this sample of houses is not necessarily mutually exclusive with household production. Furthermore, the difference between bowls of the same type are so slight that the possibility of this resulting from deliberate attempts by the manufacturer seems well near impossible.

Selection of the Divostin Material

Aside from the conditions outlined above, the prehistoric sample was examined for three other criteria, namely sufficent sample size from each household, the need for a representative portion of the vessel profile, and rim sherds of a specified vessel diameter. The minimum sample size was set at fifteen profiles from each household. It was felt that this sample size was sufficient because the analysis of the Jugtown material used the same number of vessel profiles. Any house which could not provide fifteen profiles would be eliminated from the analysis.

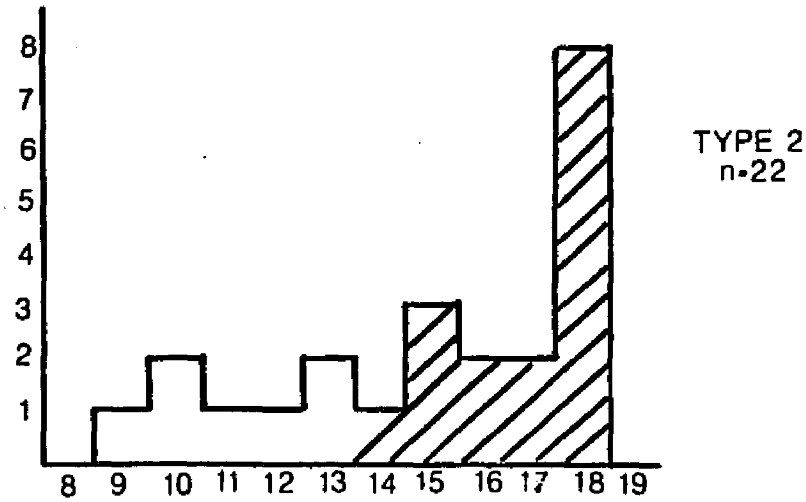
These rim sherds, however, had to have a significant portion of the vessel form represented along the profile. In this way, the point approximation method would reflect a good portion of the vessel profile. Since there was an insufficient number of reconstructed vessels from each house, it was necessary to use rim sherds. These rim sherds would have to yield ten measures along the polar coordinate grid from a constant point, 40 mm, from the (0,0) locus. The use of a larger number of measures to include a greater portion of the vessel profile would reduce the sample size to make statistical tests subject to measurement error. If the necessary measures were reduced to five or six, the sample size would increase at the expense of information about vessel profile. An examination of the profiles indicates that the sample would not be greatly increased if the necessary measures were reduced to eight.

Since sherds not necessarily attributed to any whole vessel were included in the anslysis, it is important to minimize the possibility of using sherds from the same vessel. The use of sherds from the same vessel might introduce a bias in the clustering procedure. It can be expected that sherd profiles from the save vessel would have a stronger tendency to cluser than sherds from different vessels. Therefore, when sherds could not be attributed to a single vessel, only one sherd was selected from each provenience unit, 2.5m x 2.5 m. This was accomplished in all of the houses used in the analysis with the exception of House 21, where provenience units were unfortunately mixed prior to this analysis.

The last criterion to be considered is the indeterminate size of the rim diameter as indicated by the sherd. Though rim diameters were taken of all rim sherds, their reliability and validity are dependent upon the percentage of the diameter represented by the rim sherd's chord length. Sherds whose chord lengths closely approximate the rim diameter are measured with good reliability and validity. Sherds whose chord lengths represent a small fraction of the rim diameter had measures which were widely divergent; they would often vary as much as 6 cms.

Thus, their indicated rim diameters are suspect. The rim diameters recorded indicate the median measure. This precludes the orientation of the prehistoric material in a manner similar to that described for the Jugtown material.

To compensate for this indeterminancy, all profiles were measured from a constant point along the polar coordinate grid, 40 mm from the (0,0) locus. This, however, introduces the problem of the size of the vessel and its influence upon the polar coordinate measures. Larger vessels will have distinctly different sets of measures than smaller ones because of their size alone. Thus, clustering procedures would be measuring primarily size and not shape. To minimize the size factor, only those profiles which fell into a narrow range of rim diameters were used. The range of rim diameters was determined by examining the diameters of the reconstructed vessels. For example, the reconstructed vessels of the two bowl forms show a strong tendency to cluster around a central mean, figure 83. Only those rim diameters measuring between 14-18 cm would be used. It is felt that this range would minimize the size factor while enhancing the variation in sherd profile. Size differences, however, are not completely eliminated from the analysis. This is important because the size of the vessel was a significant factor in distinguishing individuals in the Jugtown analysis. In that test, either rim diameter or vessel height were good indicators of authorship of the vessel. The use of the point approximation measures, from a set of rim sherds within a specified range of diameters, at a constant point along the polar coordinate grid would include both size and shape factors.



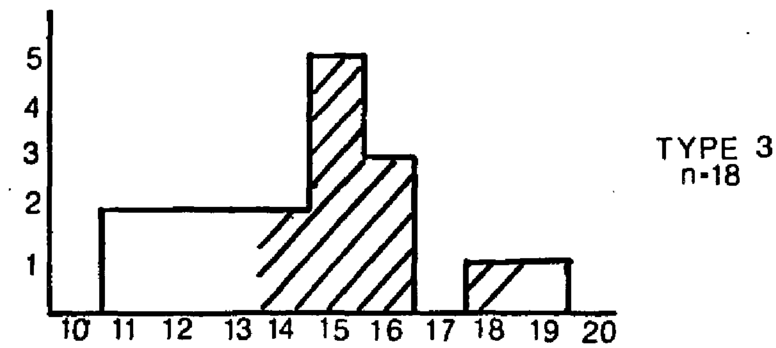


Fig. 83. Rim diameters for complete vessels. Cross hatching indicates range of diameters used in the analysis.

This procedure to neutralize the size factor may seem to introduce a selection bias. This bias, however, will have a tendency to reduce the likelihood of differences emerging between households. Since size was a significant factor, both in my own work at Jugtown and the work of White and Thomas (1972), the results of individual household production for the prehistoric material becomes even more revelaing. It is further argued that within the range of rim diameters used in the analysis, each household should have its own pattern of production which differs slightly from other houses if the pattern is non-specialized. The differences at Jugtown between potters for each of the measures was often less than 2 cms (see tables 5-10) on even the best discriminating scores. Thus the use of a range of 5 cms would seem to be sufficient for individual differences to emerge.

The use of these criteria allowed only two bowl forms to be included in the analysis, vessel forms 2 and 3. Importantly, the ten measures necessary for inclusion in the analysis cover a broad portion of the entire vessel profile. If large jars had been included in the analysis, the ten measures would only include the rim and a small portion of the neck. The use of bowls is fortunate because the greater representation of the vessel profile provides a more meaningful evaluation of the variation of the bowl form.

The application of the above mentioned criteria resulted in the elimination of House 99 from the analysis. Houses 91 and 100 were eliminated from the analysis of Type 3 bowls because they could not provide a large enough sample size. Unfortunately, the ceramics from House D and House 19 were not available for inspection.

The different sample sizes from each of the houses would make the pairwise comparisons difficult to evaluate. These differences increase the probability of overlapping profiles from the house with the larger sample into the cluster of the other house. Therefore, the sample of profiles from each house was made equivalent to eliminate this problem. This was accomplished by randomly reducing the sample from each house to the N found in the house with the smallest number of profiles. This resulted in the use of seventeen profiles for both bowl forms.

Before proceeding to the analysis of the profiles, one other problem and its solution need description. This concerns itself with the representation of the sherd to be used in the analysis. Unlike the Jugtown material in which pictures where taken of vessels which were properly oriented on their bases, the prehistoric material presented an entirely different situation. Sherd drawings would have to be made with certainty of their accurate representation of the sherd form and orientation. Eyeballing of the profile, as is often done in archaeological reports, would not be useful because of the possible introduction of bias by the drawer and inevitable non-accuracy. A procedure is needed which would faithfully record the minor variations in sherd profile. One solution to this problem is presented by McPherron (1966:55-56), who outlines a useful solution to the problem. All sherds used in the analysis were drawn in this manner.

PCA of the Divostin Material: Type 2[1]

The distinctness of the PCA analysis of the Divostin Type 2 bowl provided sufficient distinctness between houses to suggest that ceramic

[1]See figure 84 for rim profiles.

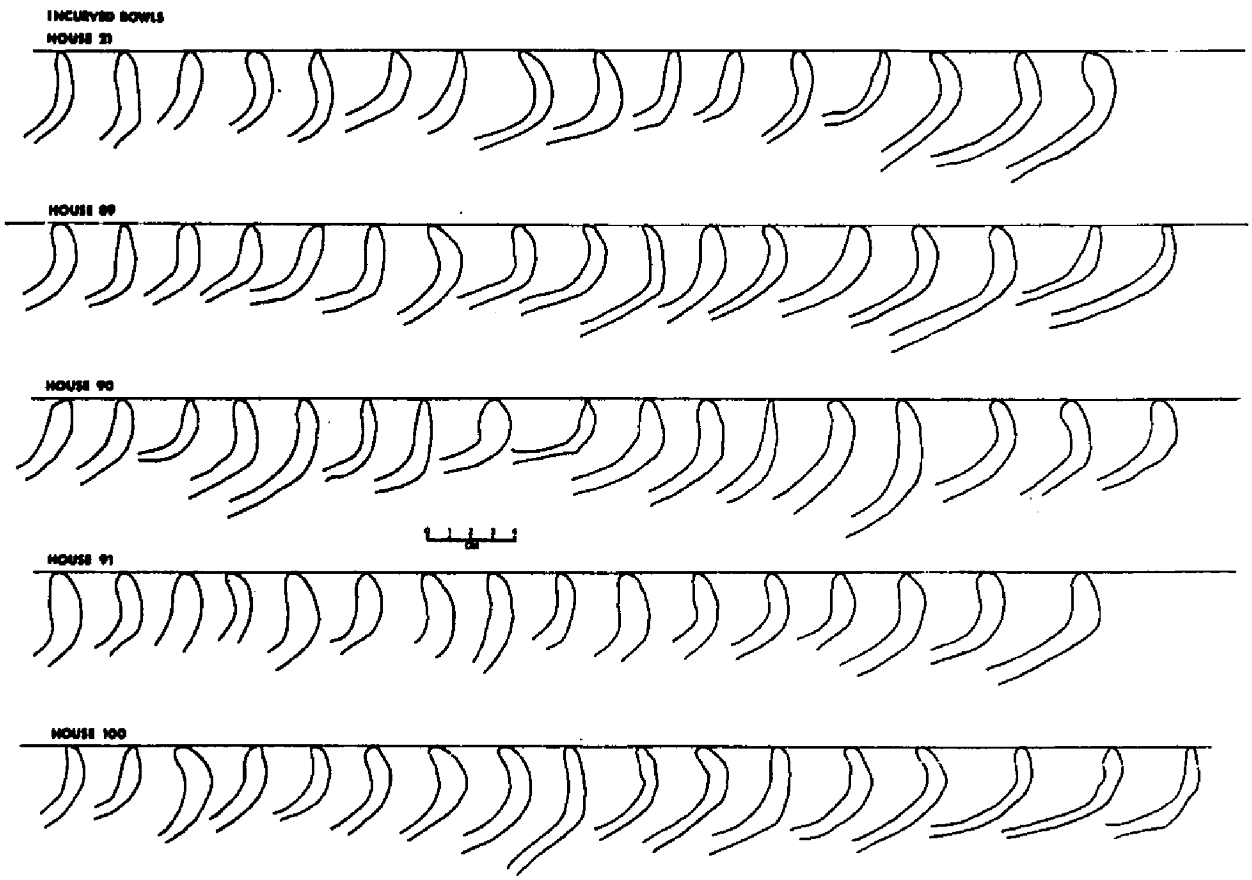


Fig. 84.

production for this bowl was located within each of the houses, with the possible exception of House 90. The plots are shown in figures 85 to 104 and the relevant PCA information is presented in appendix C. A summary of the number of profiles of one house in the cluster of the other house, herein called non-distinct profiles, for each pairwise comparison is provided in table 16.

TABLE 16

NUMBER OF NON-DISTINCT PROFILES IN EACH COMPARISON

Pairwise Comparison	Components 1 and 2	Components 1 and 3
21-89	8	8
21-90	11	7
21-91	7	7
21-100	7	8
89-90	12	9
89-91	8	5
89-100	12	9
90-91	7	10
90-100	11	11
91-100	8	5
	91	79

When compared to Jugtown material, the number of non-distinct profiles is considerably greater. I believe this to be caused by several factors. First, the number of profiles in the prehistoric comparisons is somewhat larger than the Jugtown tests, 34 to 30. The four extra profiles increased the likelihood of more non-distinct profiles in the Divostin analysis. Second, the acceptable limits of variation permitted by the Divostin potters may be greater than that desired by the

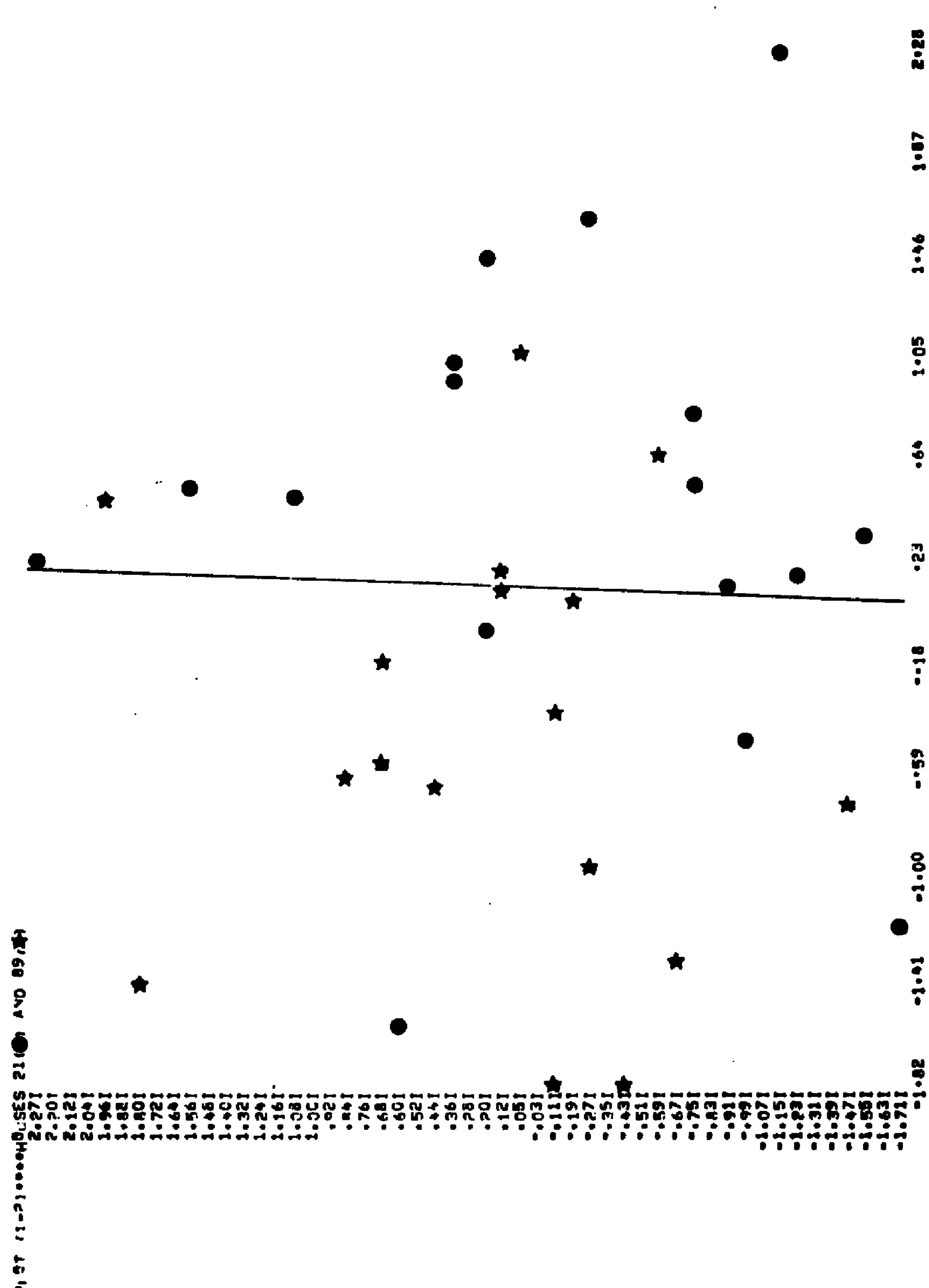


Fig. 85.

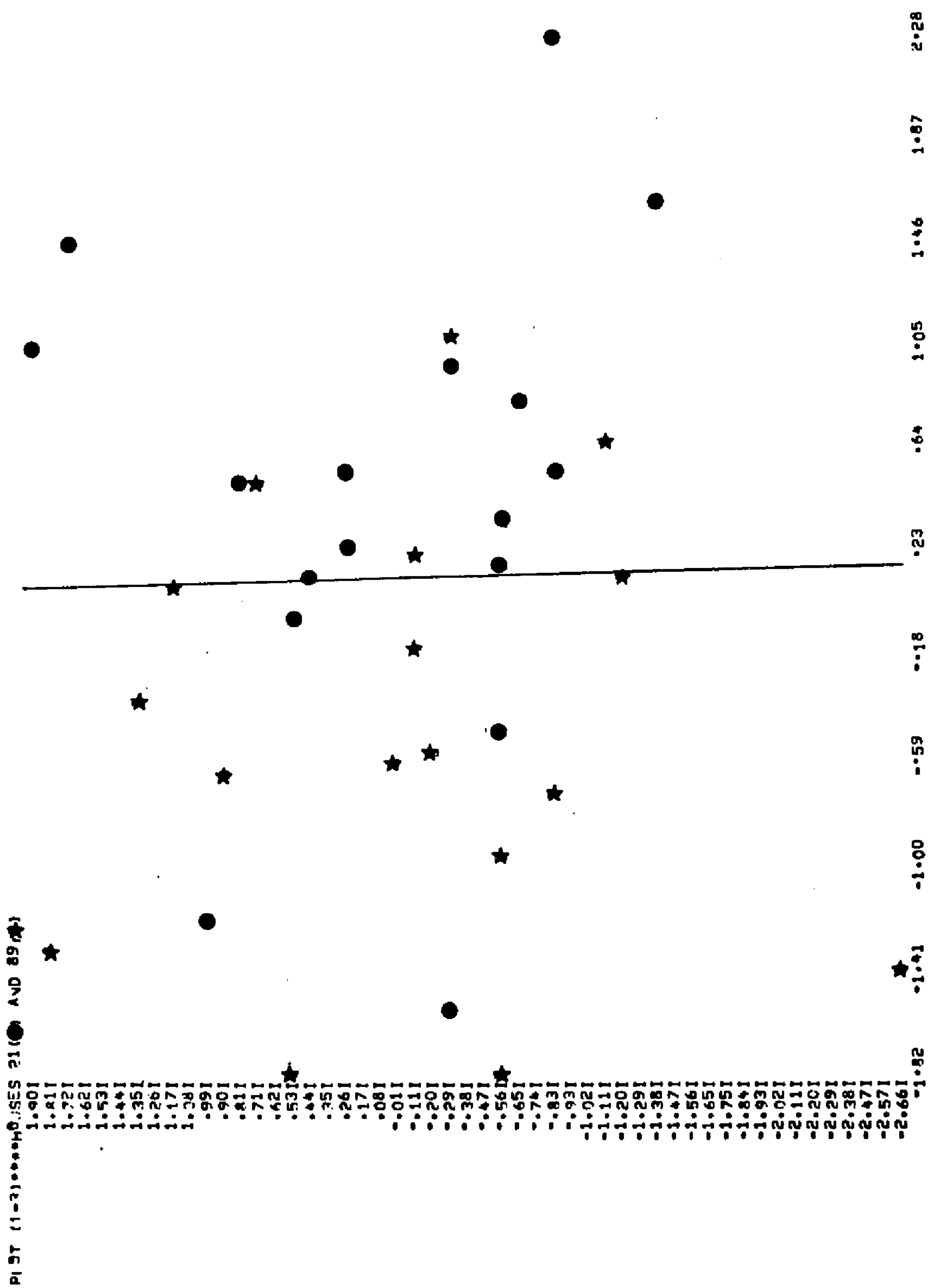


Fig. 86.

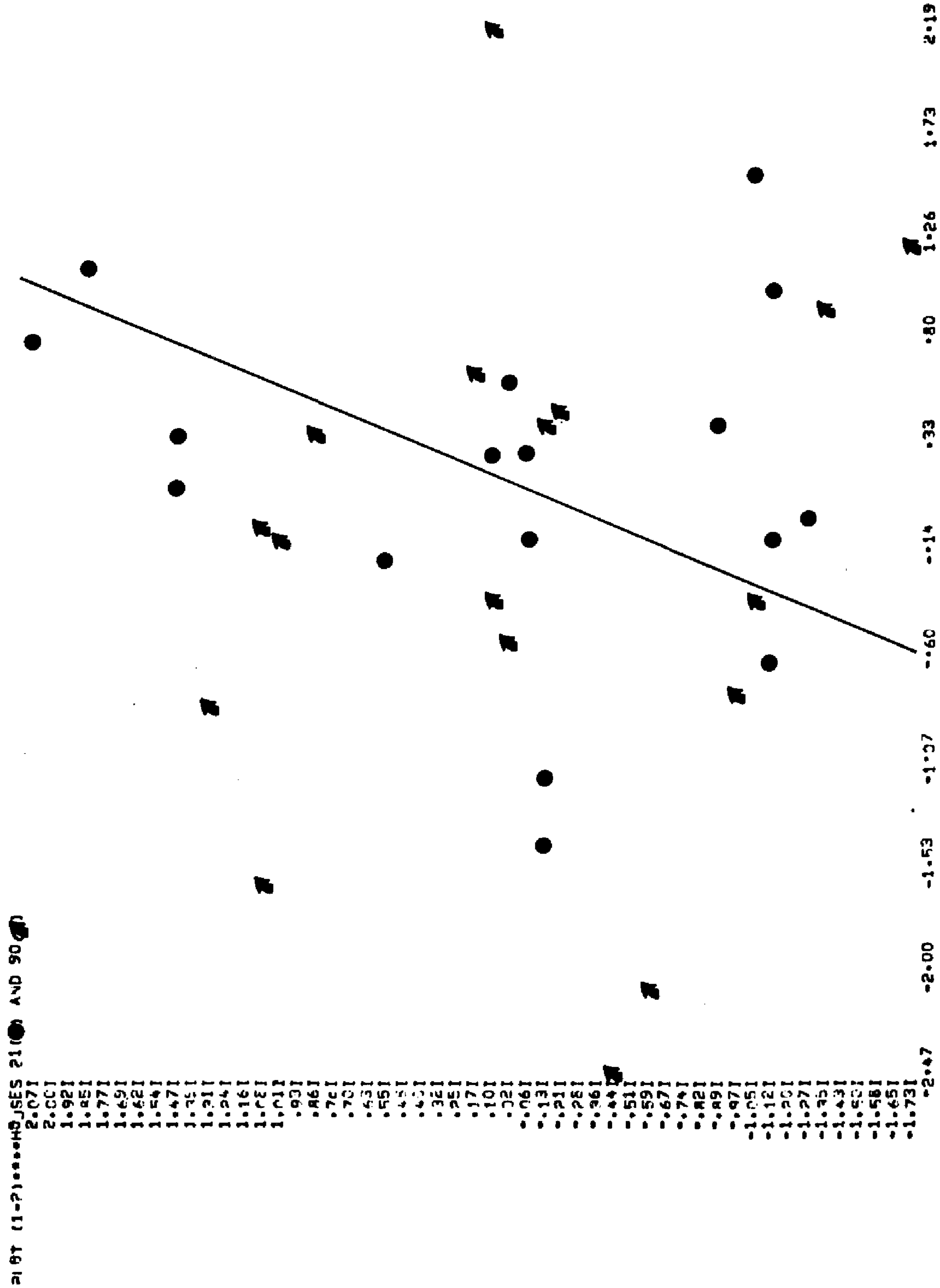


Fig. 87.

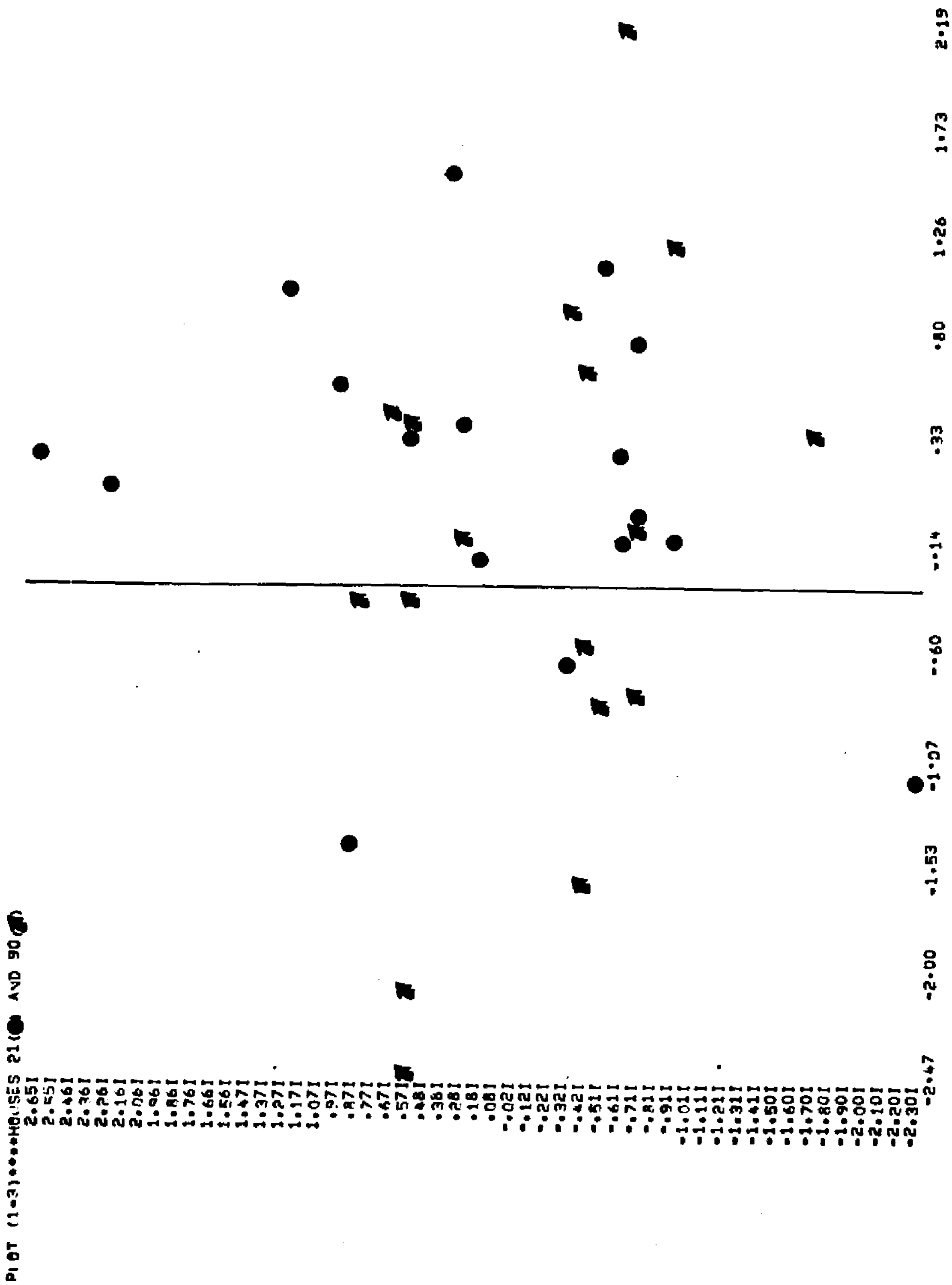


Fig. 88.

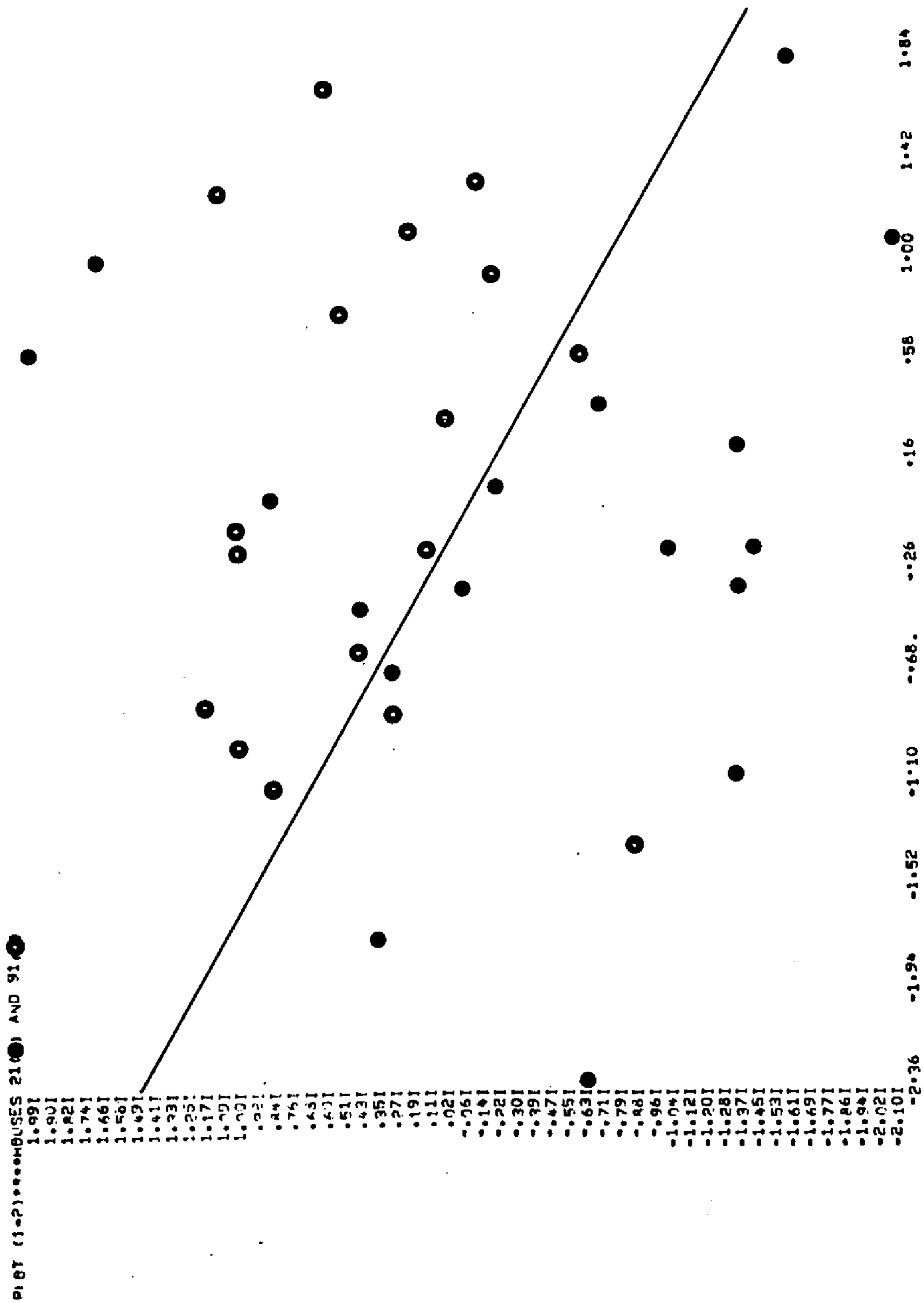


Fig. 89.

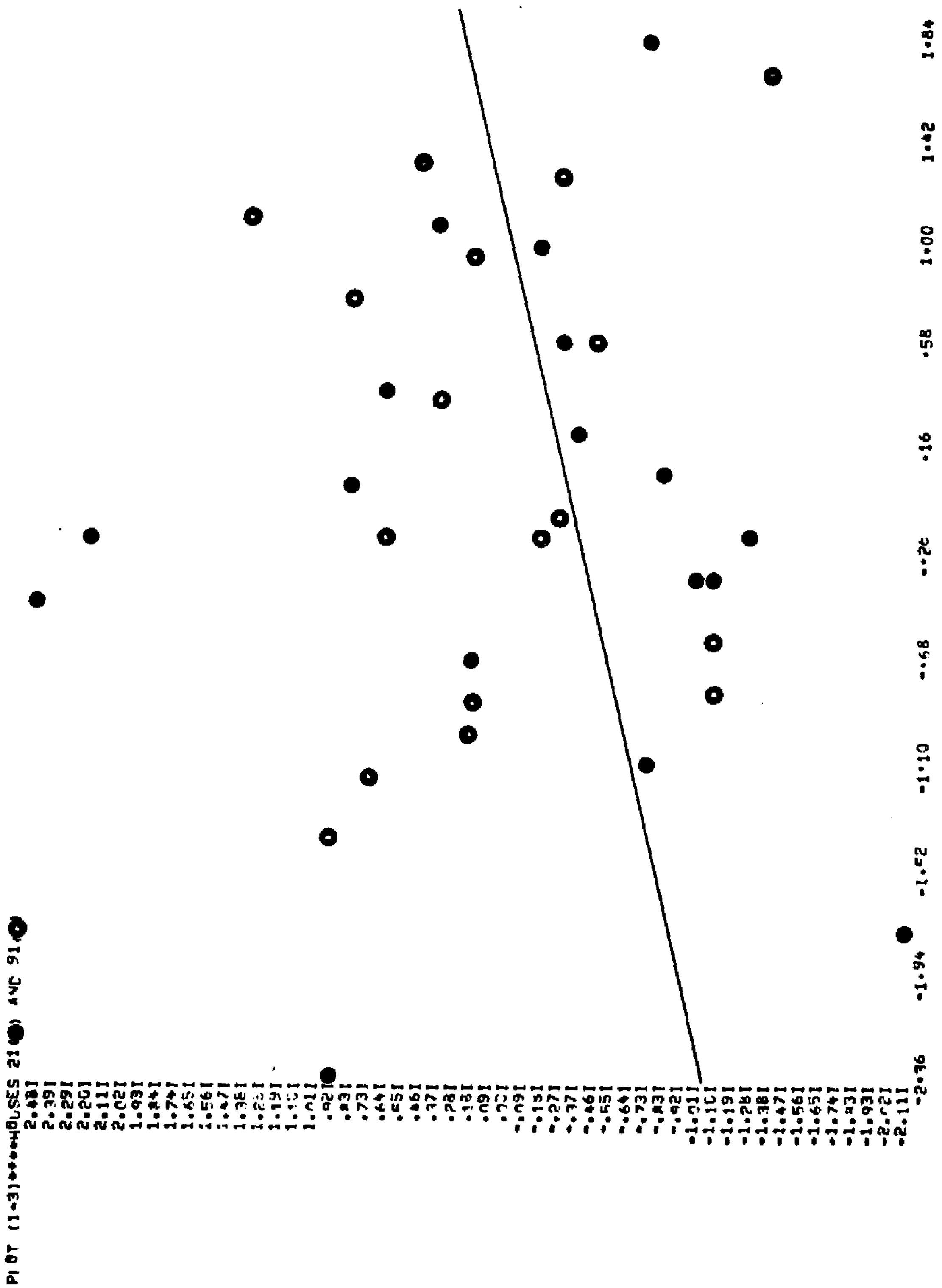


Fig. 90.

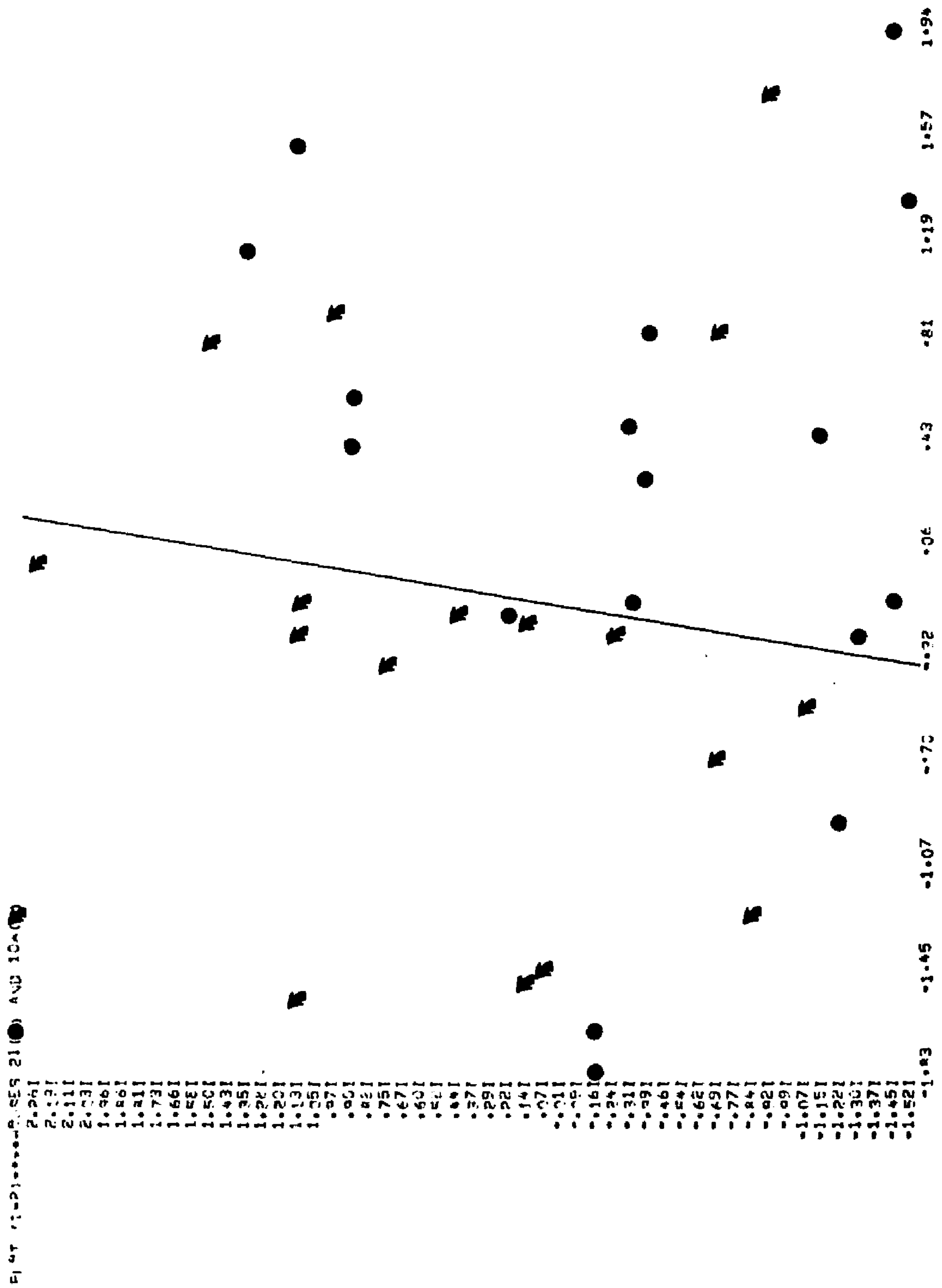


Fig. 91.

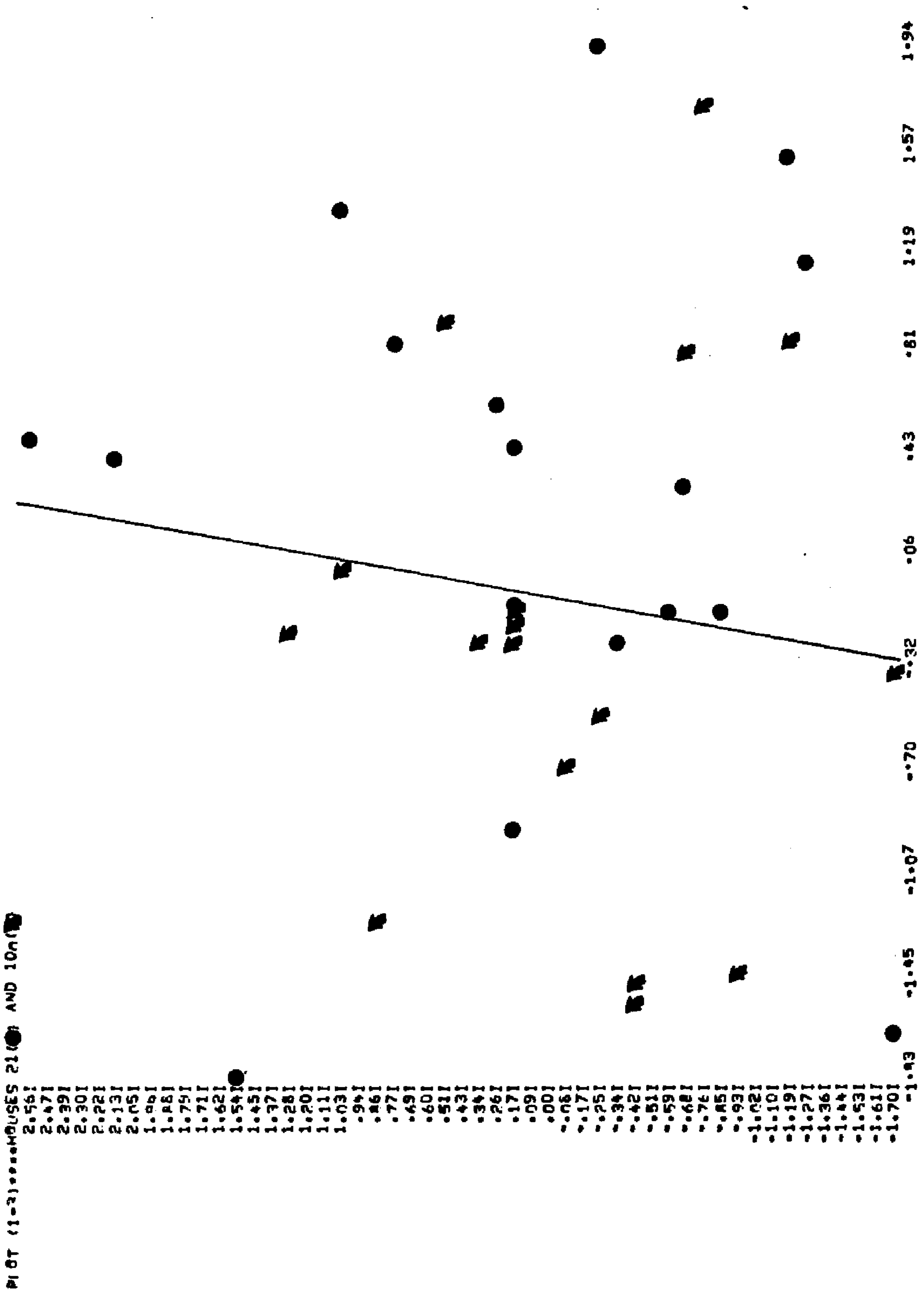


Fig. 92.

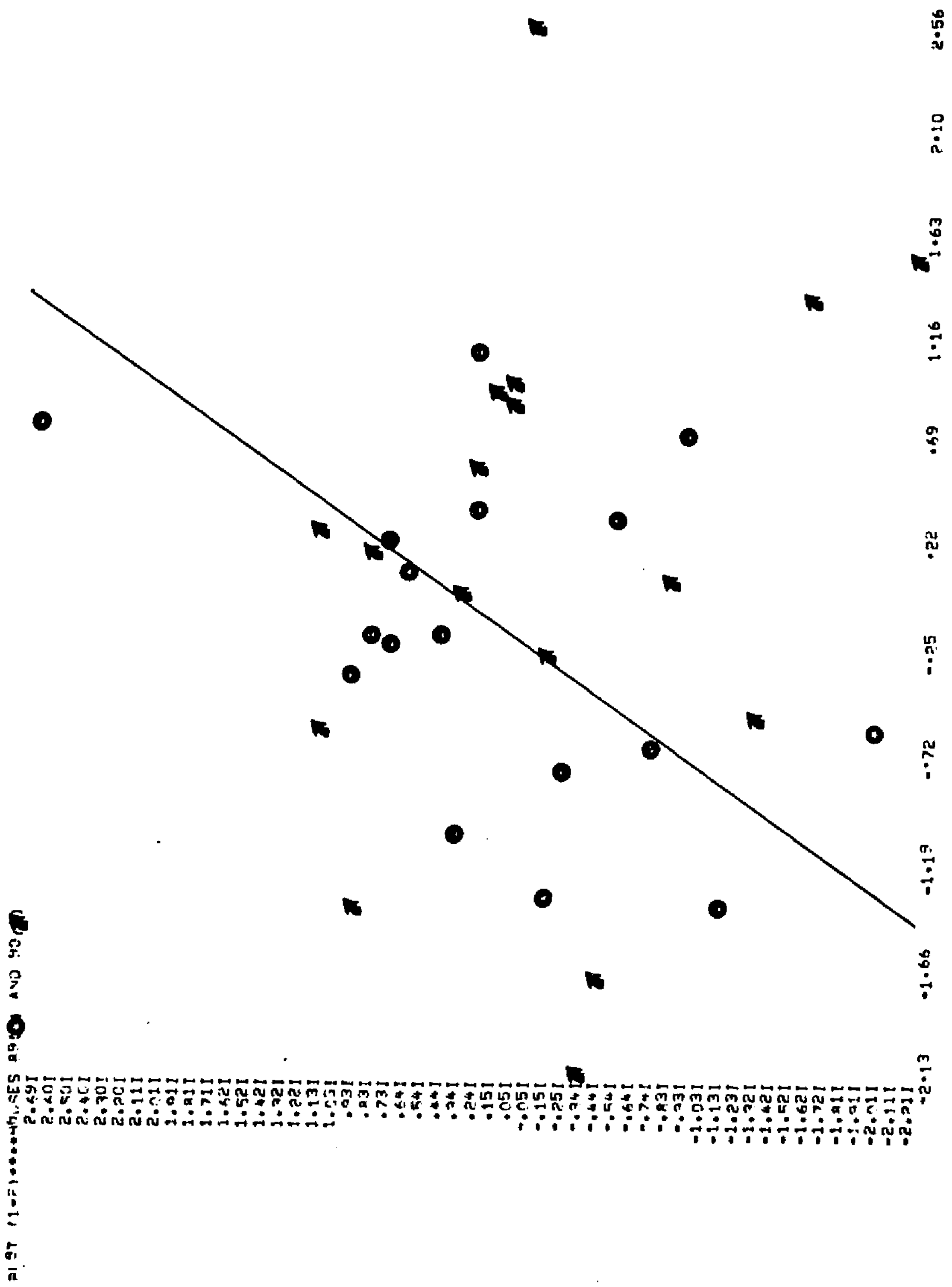


Fig. 93.

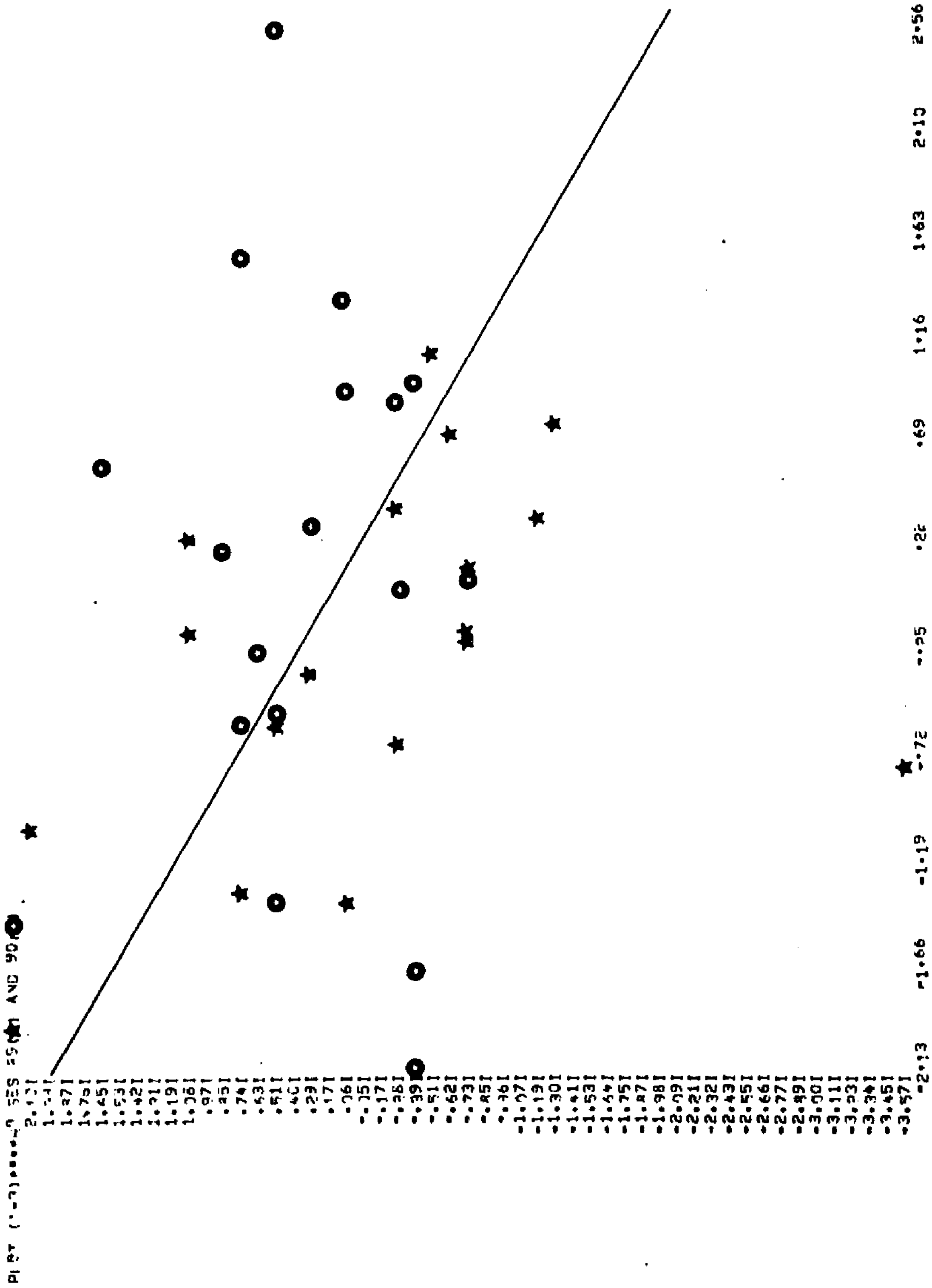


Fig. 94.

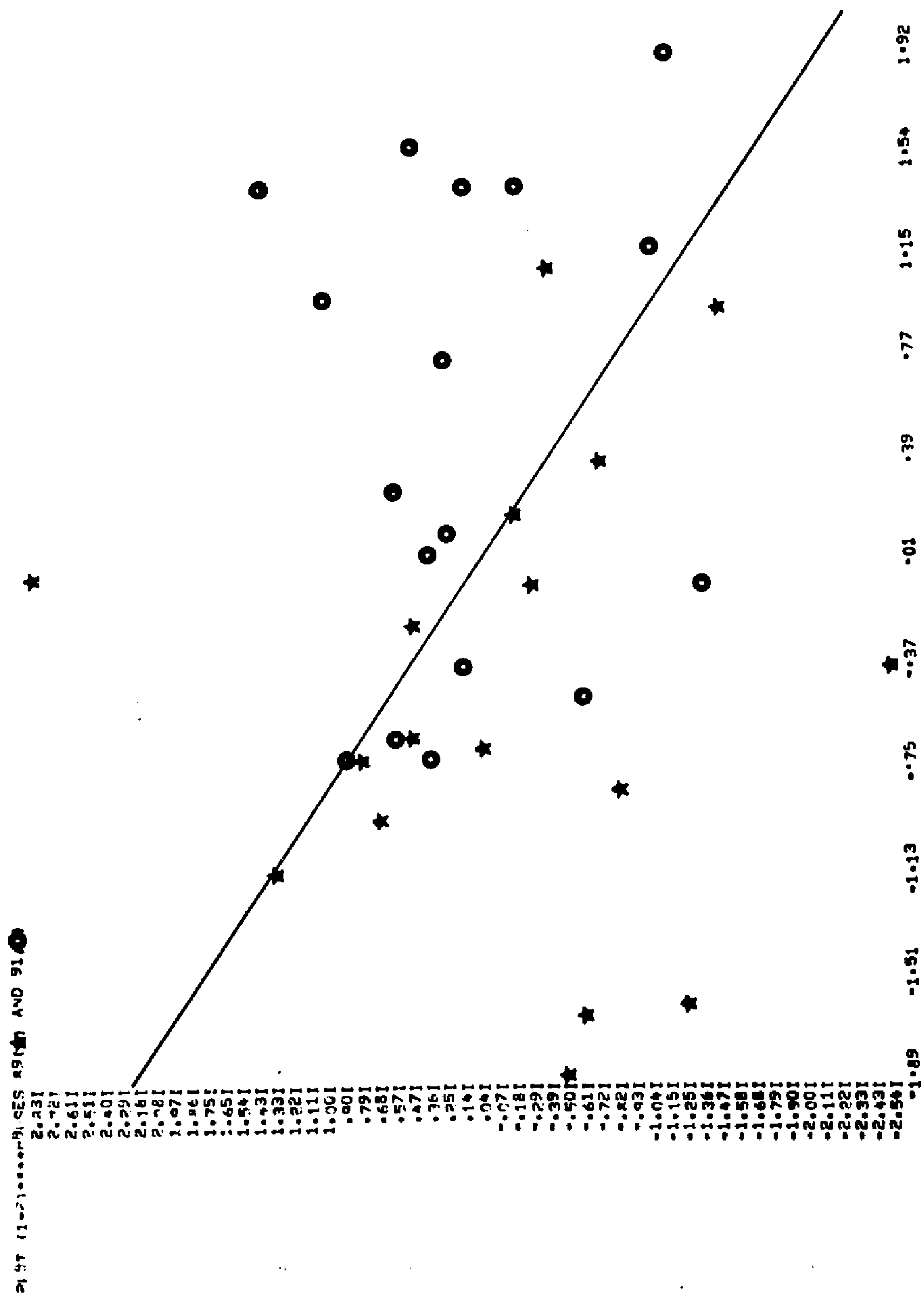


Fig. 95.

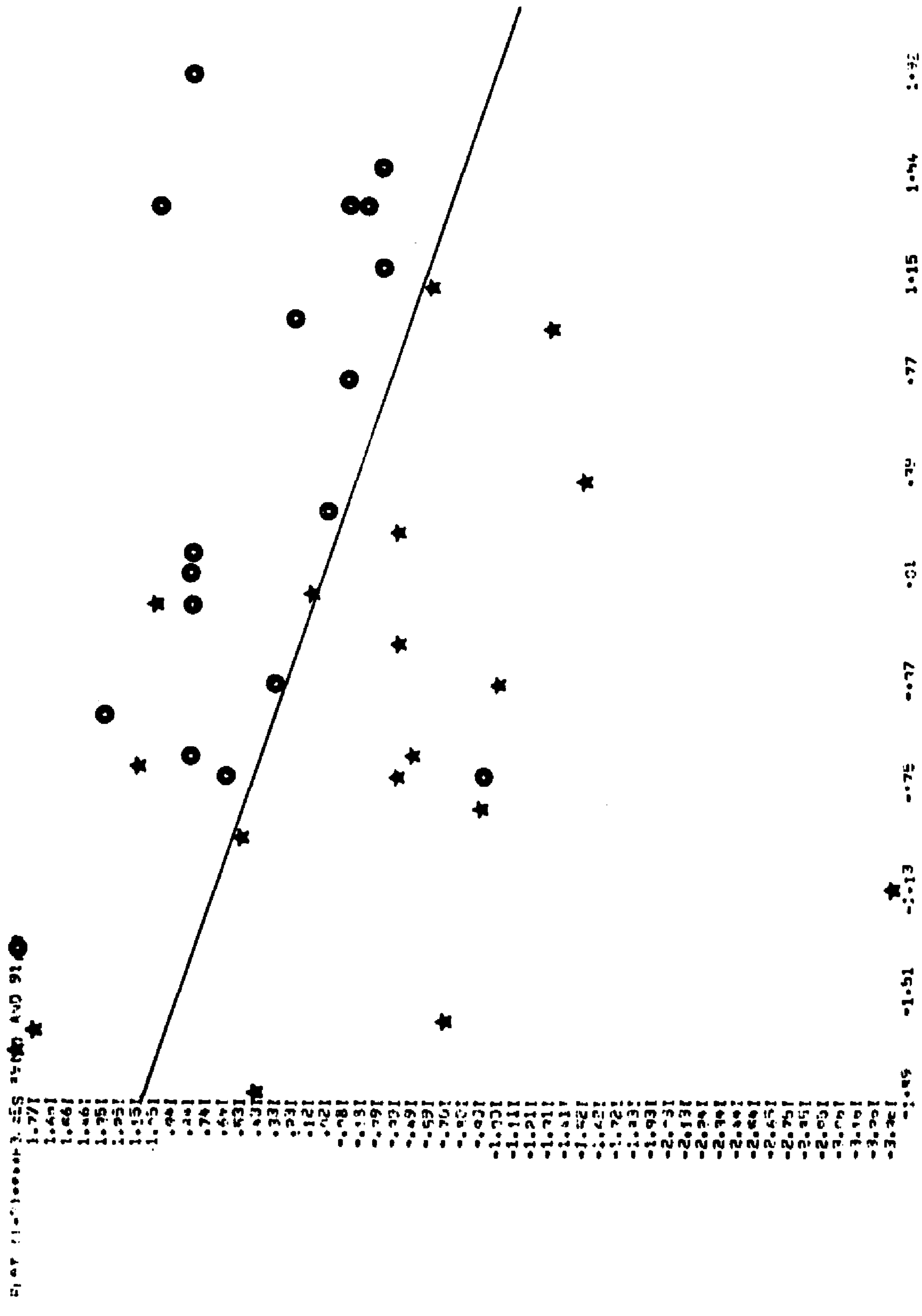


Fig. 96.

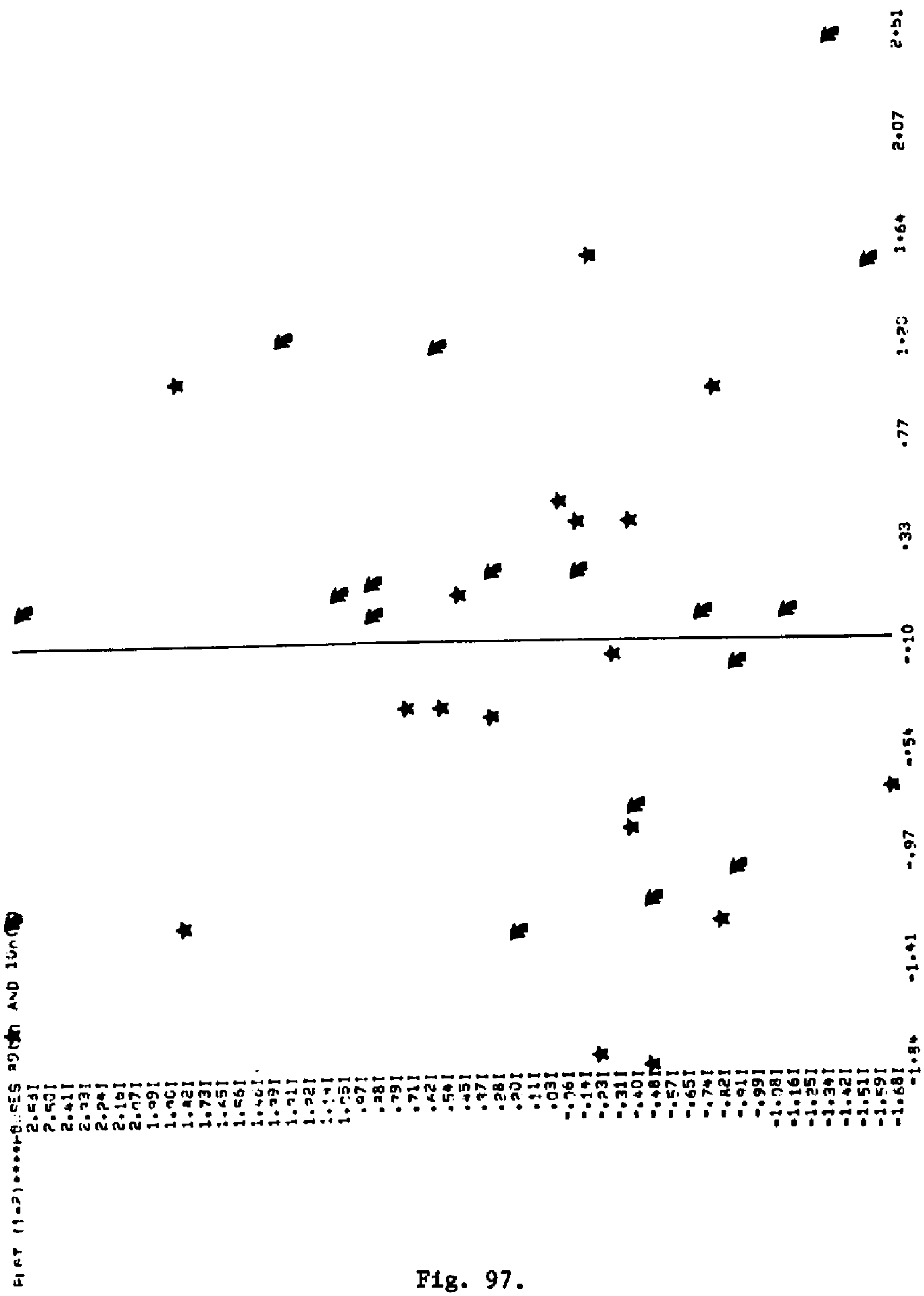


Fig. 97.

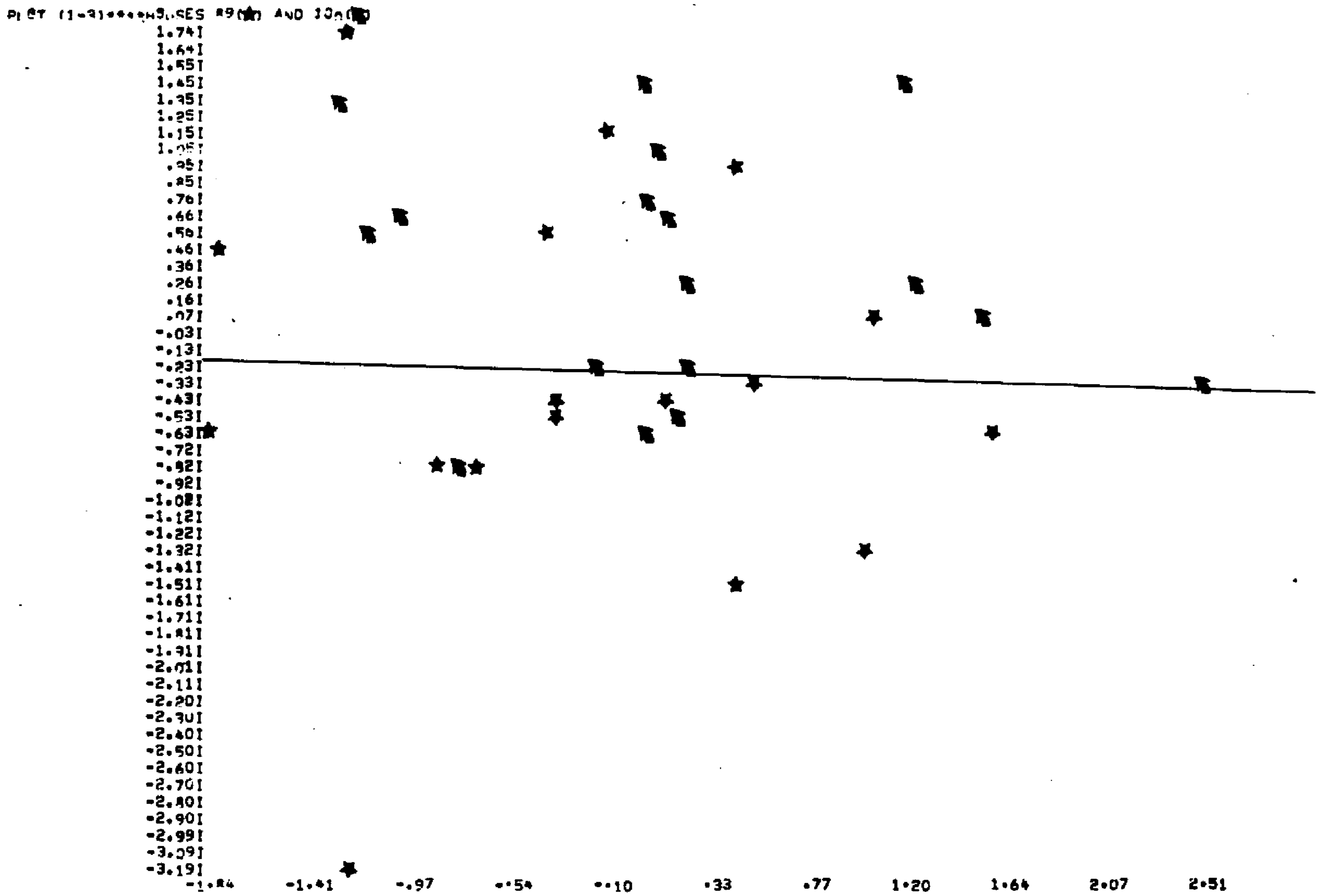


Fig. 98.

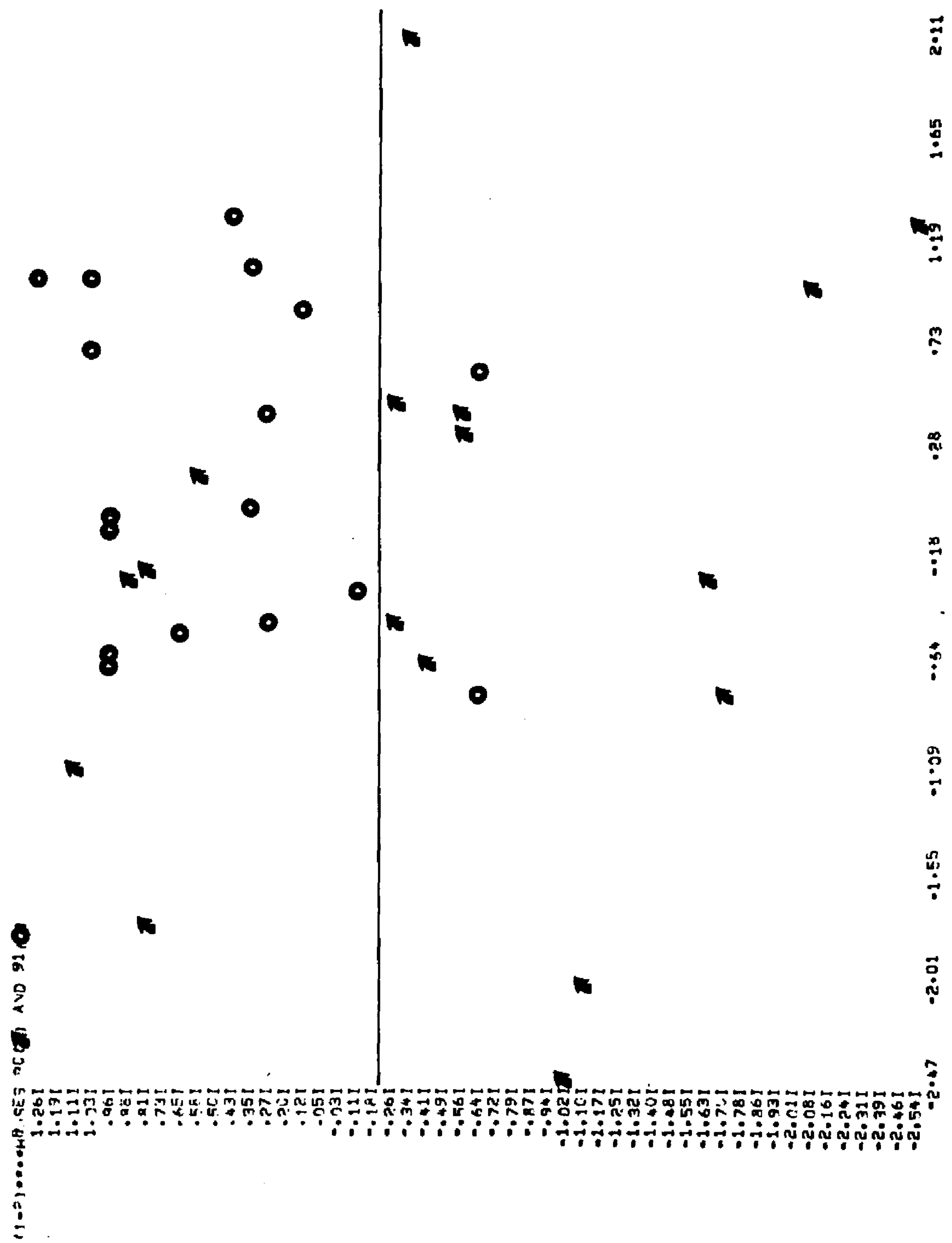


Fig. 99.

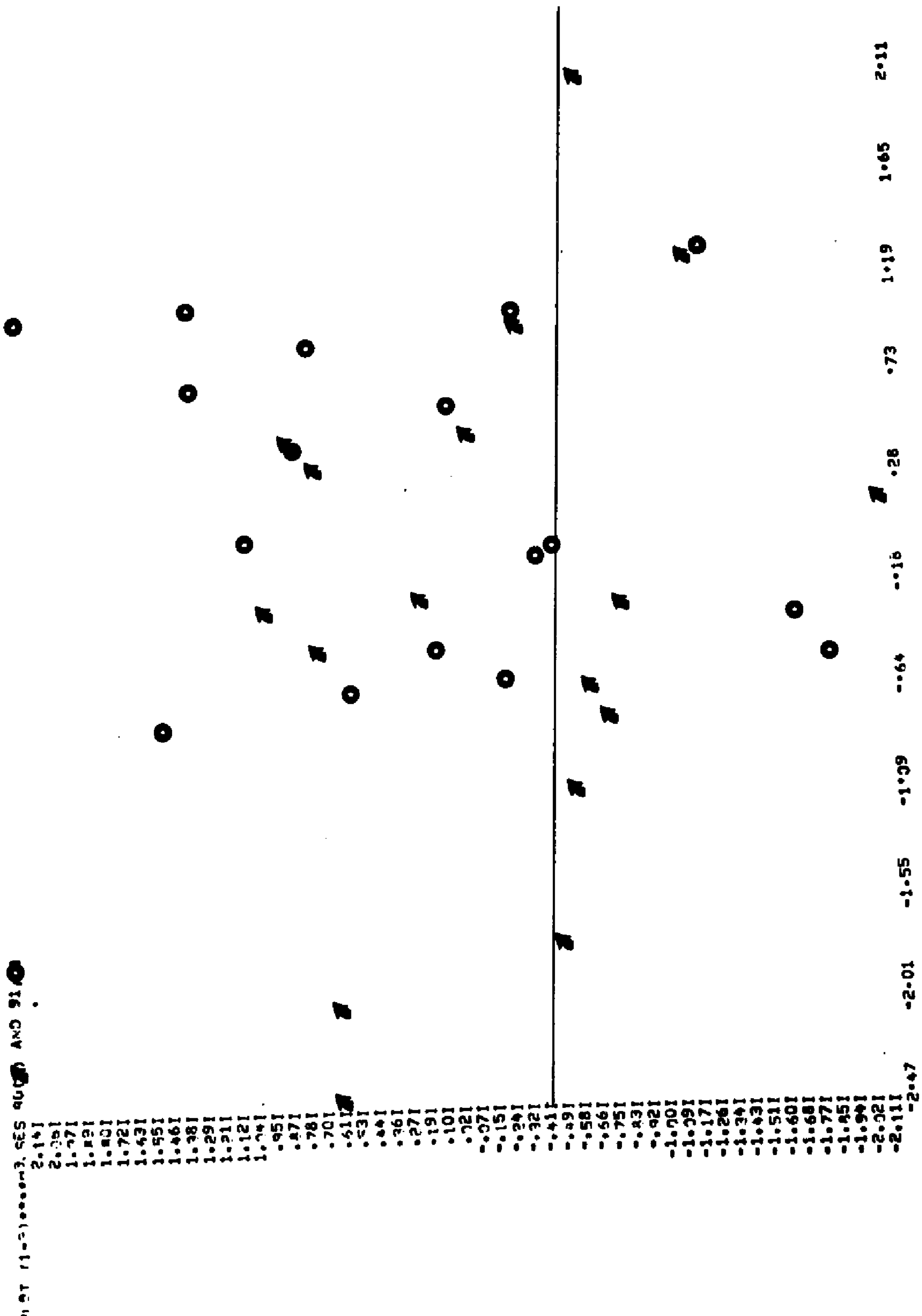


Fig. 100.

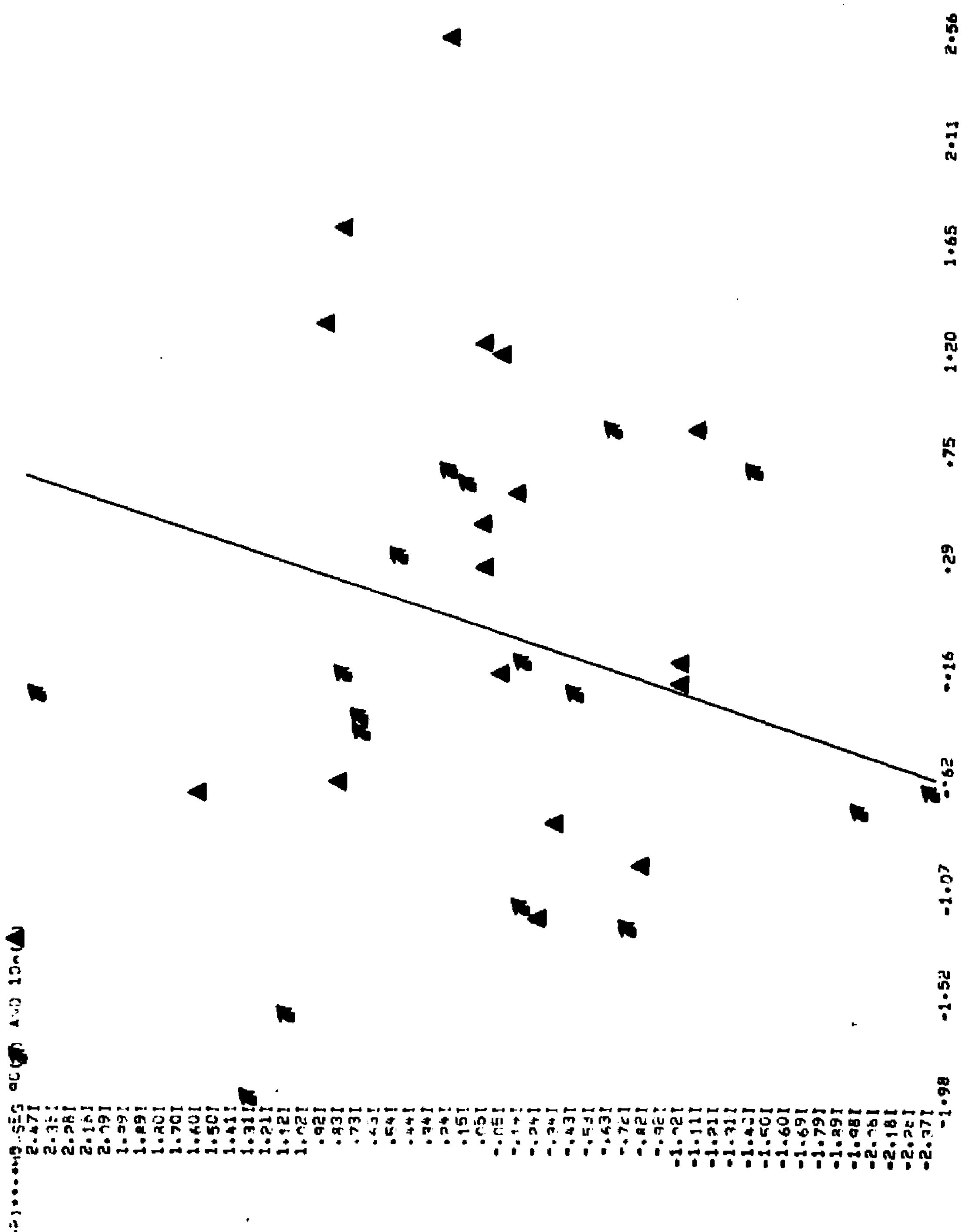


Fig. 101.

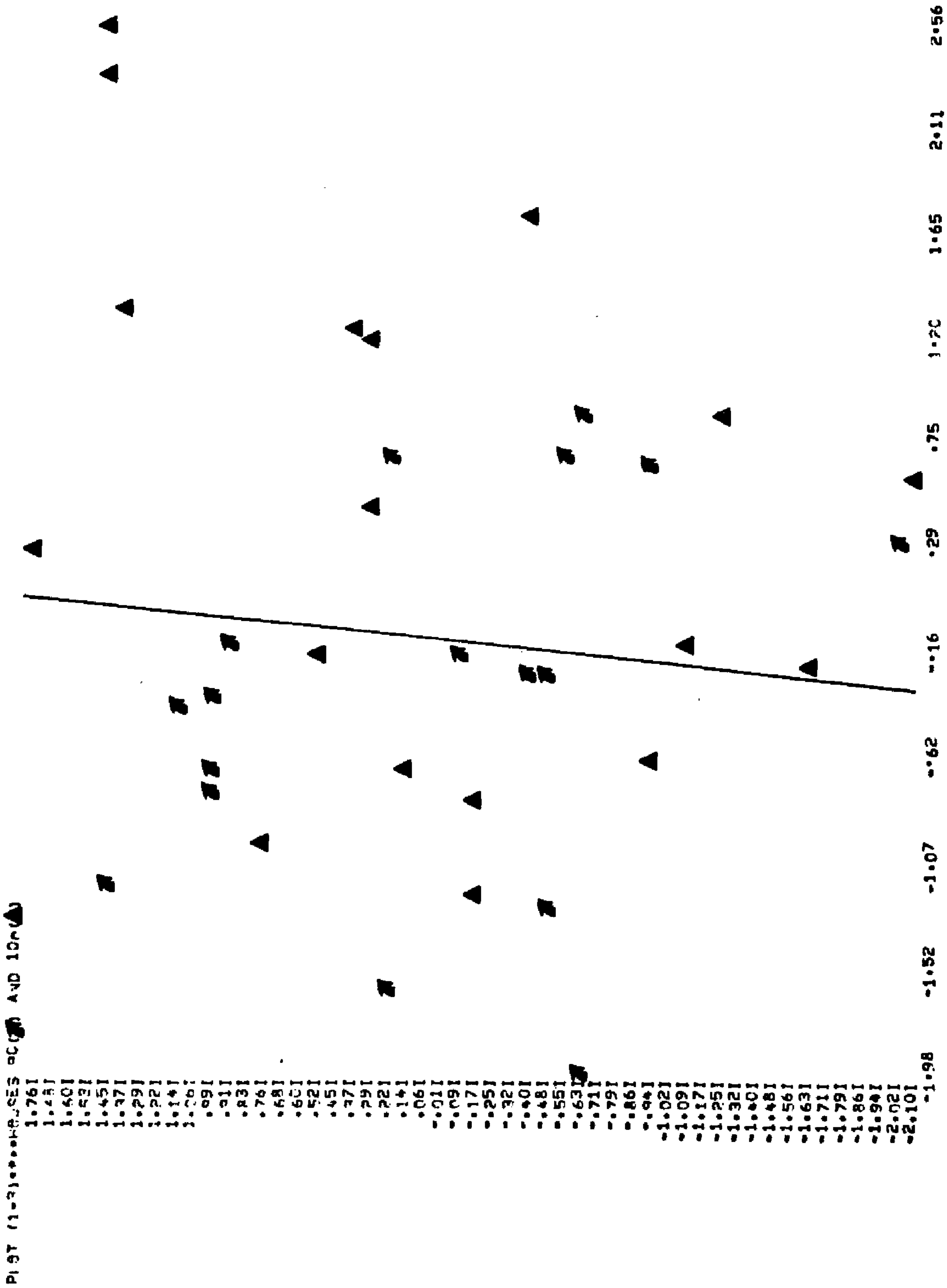


Fig. 102.

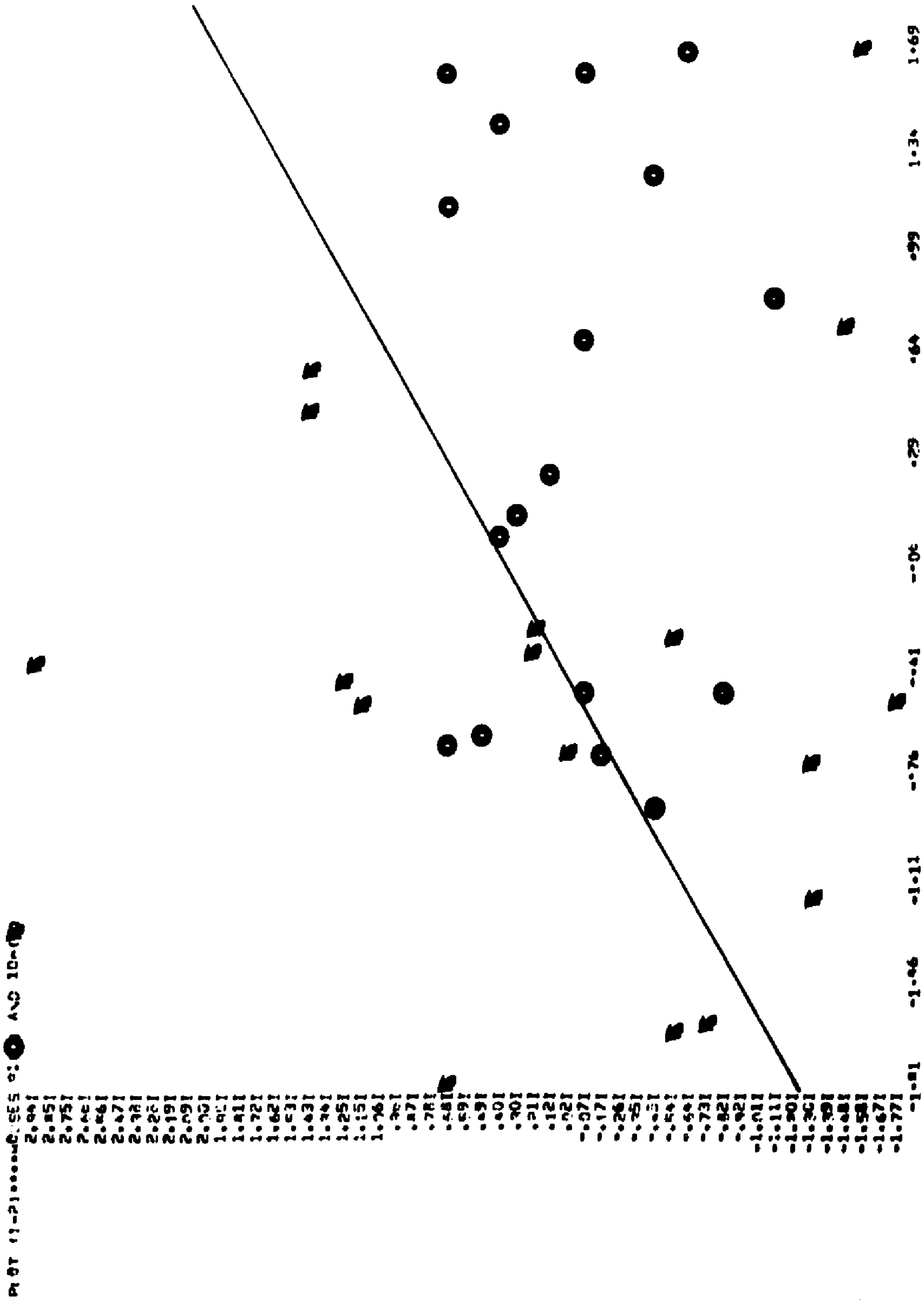


Fig. 103.

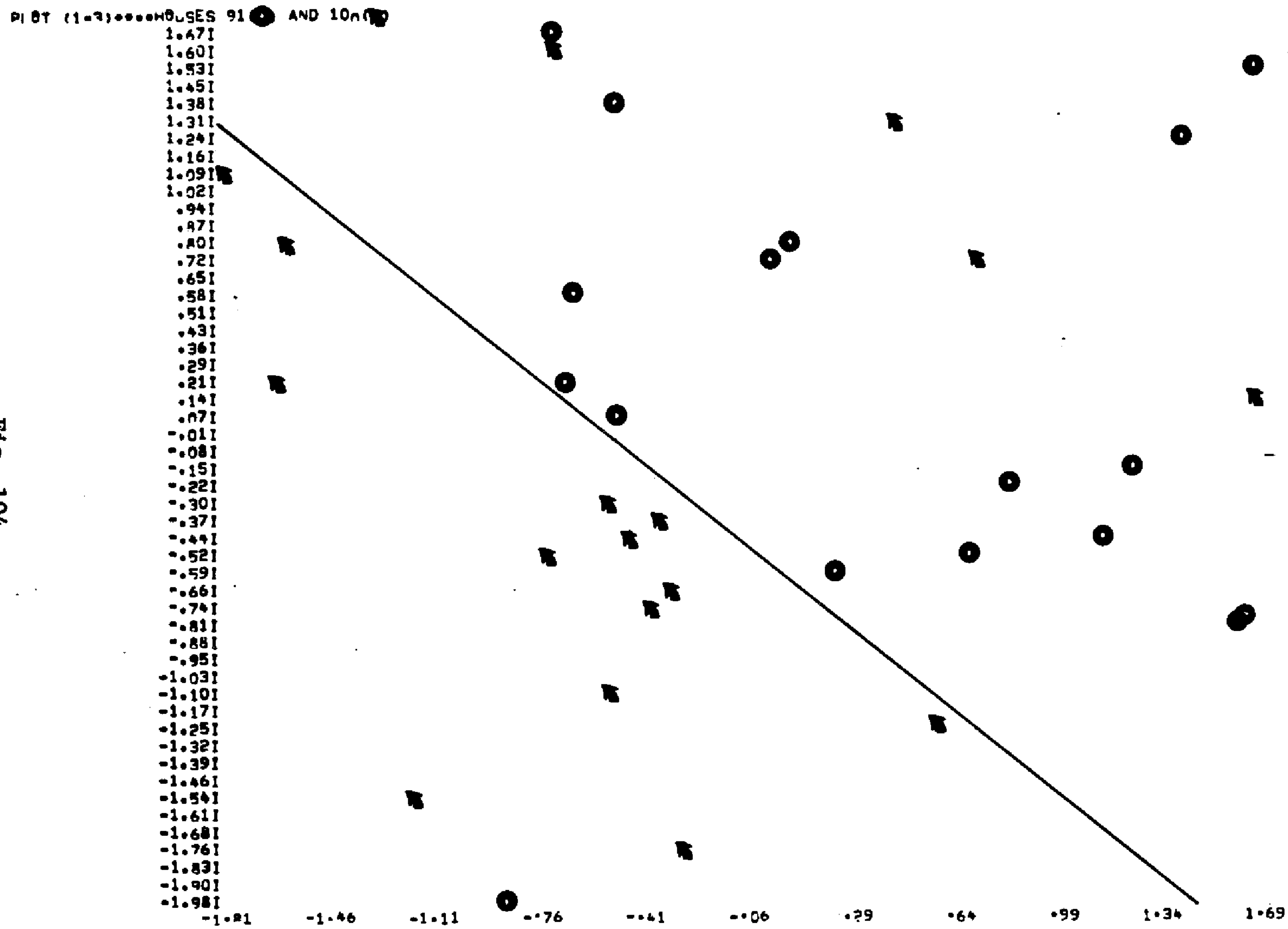

PLOT (1-3)....HOUSES 91 AND 10
1.47I
1.60I
1.53I
1.45I
1.38I
1.31I
1.24I
1.16I
1.09I
1.02I
.94I
.87I
.80I
.72I
.65I
.58I
.51I
.43I
.36I
.29I
.21I
.14I
.07I
-.01I
-.08I
-.15I
-.22I
-.30I
-.37I
-.44I
-.52I
-.59I
-.66I
-.74I
-.81I
-.88I
-.95I
-1.03I
-1.10I
-1.17I
-1.25I
-1.32I
-1.39I
-1.46I
-1.54I
-1.61I
-1.68I
-1.76I
-1.83I
-1.90I
-1.98I
-1.81
-1.46
-1.11
-.76
-.41
-.06
.29
.64
.99
1.34
1.69

Fig. 104.

Jugtown potters. The Jugtown potters frequently spoke of a determination to maintain the form indicated in the catalog. While this is impossible to assess in any measurable way, for Divostin this still may have been a source of the increased variation.

Third, and perhaps most significant, the method of manufacture is not the same for both sets of pottery. The prehistoric pottery is hand made, whereas the Jugtown pottery was thrown on a wheel. It appears from an analysis of vessel symmetry of complete vessels from both areas that vessel symmetry is considerably higher in the Jugtown material. Correlational coefficients of the Jugtown material comparing opposite profiles on the same vessel consistently yielded values 0.96 or better. A similar analysis of the Divostin material using reconstructed complete vessels yielded values no higher than 0.82. The increased variability in the hand made Divostin materials would tend to lessen the separation between potters or households.

Fourth, the number of potters within a household was probably more than one in some of the Divostin houses. If this is true, the distinctness observed in the test is even more remarkable. House sizes range from five to six meters wide by nine to sixteen meters long. If we use some of the measures for estimation of population size of a household based on floor space (Narrol 1966 and Cook and Heizer 1968), the population for each house is between five and ten. This raises the possibility of more than one potter in a household if we consider ethnographic examples (DeBoer and Lathrop 1966). This example shows either two or more adult members manufacturing ceramics or even a mother and daughter producing the pottery. The probability of multiple producers within the house makes the clustering stronger than one might deduce from the numbers alone.

The fifth, and again a most important factor, concerns itself with time. Earlier it was argued that the vessels within the houses were contemporaneous on a macroscale, but not necessarily from the same production event. The vessels within the house represent the accumulation of pots over a number of production events, if ethnographic models are used (DeBoer 1974 and David and Hennig 1972). The experimental test on idiosyncratic patterning were all conducted over a short period of time. The ceramics at Jugtown were produced within an hour by each potter, the bifaces used by Gunn (1972) were produced over a week, and the *aré* and *aré kou* of the Aluni were selected over a two week period (White and Thomas 1972). It is argued here that the short time span involved in the experimental situation artificially inflates the degree of distinctness between artisans. White and Thomas (1972) noted in their study that trends in the measurements were evident in the TMDs over the two week period. Thus, increased variability would be expected in the bowl forms which might have accumulated over a one or two year period, spanning several production events.

A sixth, and still significant factor, can be seen in the time devoted by each person in a household to ceramic production. The expected range of variation among the full-time potters (probably leading to fewer over-lapping profiles) would be less than those potters who are part-time specialists. Increased frequency of production and the related familiarity with production techniques would lead to a smaller range of variability for the specialist potters. Support for this argument is seen in the Jugtown analysis. Though each potter is considered a specialist, each has varying degrees of experience in the craft. Potter C, the most experienced, was least variable. His cluster was the tightest in all the comparisons. The tight cluster of points reflects the smaller degree of variability in his sample of profiles. Potter B, the least experienced, had the widest range of variability as expressed by the broad distribution of his profiles. If Divostin is not a specialist village for ceramics, each potter can then be seen as devoting only some of his/her time to the craft. Therefore, more variability is expected in the Divostin sample or profiles because the artisans were only part-time potters, who produced ceramics as the occasion demanded. This would lead to more overlapping profiles.

In order to demonstrate that the established clusters were not the result of chance, a series of thirty-four two digit numbers was drawn from A Million Random Digits (Rand Corporation 1955). The first 17 were assigned the letter A, and the second 17 were assigned the letter B. These numbers were then plotted on conventional graph paper to determine if any significant clusters would emerge. In each of the seven tests conducted on random numbers, the number of non-distinct points was twelve or more (see appendix D). In the twenty plots of the prehistoric material (including Components 1 and 2 and 1 and 3), only six of the plots had ten or more non-distinct profiles (ten points was chosen as the cutoff point, to be on the conservative side). Significantly five of the six comparisons involved profiles from House 90. It appears then that the other houses had the production of this bowl form located within the household. The non-distinctness of House 90 can most economically be seen as resulting from the wide range of variability of the potter's within the house. Clearly the overall village pattern for this bowl form is household.

One further point deserves mention. In the discussion of the Jugtown material, it was seen that the most sensitive indicators of individual production were those components which accounted for the greatest percentage of variation in the tests. The analysis of this prehistoric material shows that Components 1 and 3 are as good, if not better, an indicator of individual production as Components 1 and 2. In six of the ten comparisons, Components 1 and 3 distinguished individual houses better than Components 1 and 2. Since Components 2 and 3 do not discriminate between houses at all, it appears that Component 2 may be accounting for some other variable as yet undetermined.

PCA of Divostin Type 3 Bowl

The principal component analysis of the other bowl form (see figure 105 for rim profiles) shows that each house is distinct and is consistent with the hypothesis for household production. The plots of the component scores are presented in figures 106-111 and summarized in table 17. The loadings for each variable are presented in appendix E. In each plot, the number of non-distinct profiles is less than ten. The absence of craft specialization for this bowl form is testimony to the skill of potters within these houses and probably the entire village. This bowl form, unlike the previously analyzed form, is thin walled and well decorated. The decorations invariably are formed by complex curvilinear fluted patterns which repeat themselves around the vessel three to six times.

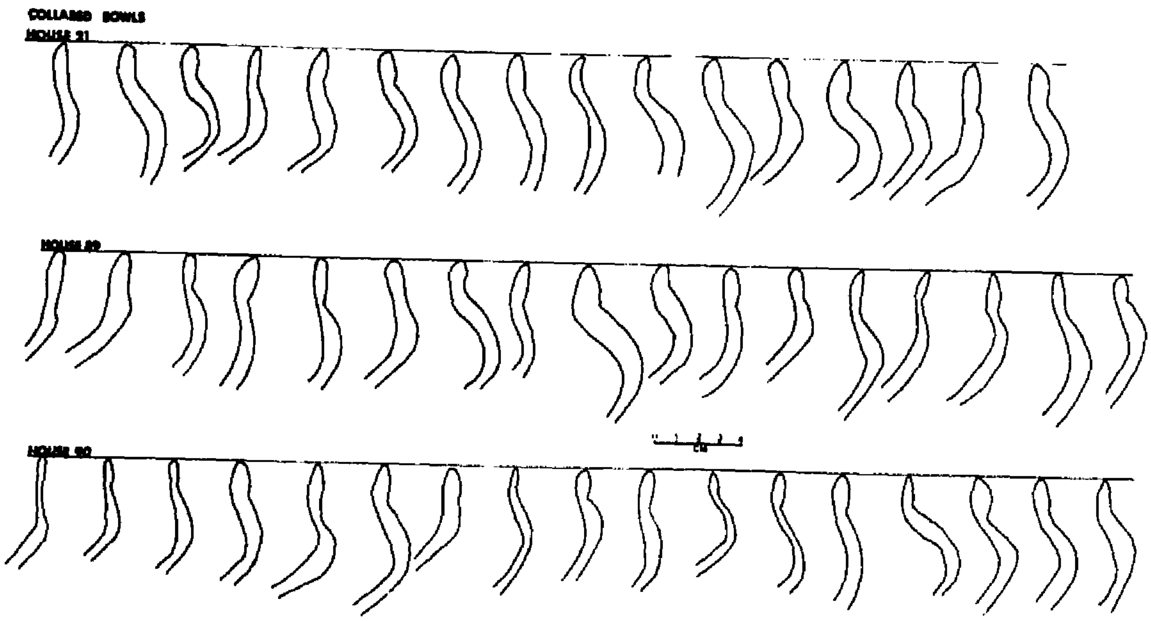


Fig. 105.

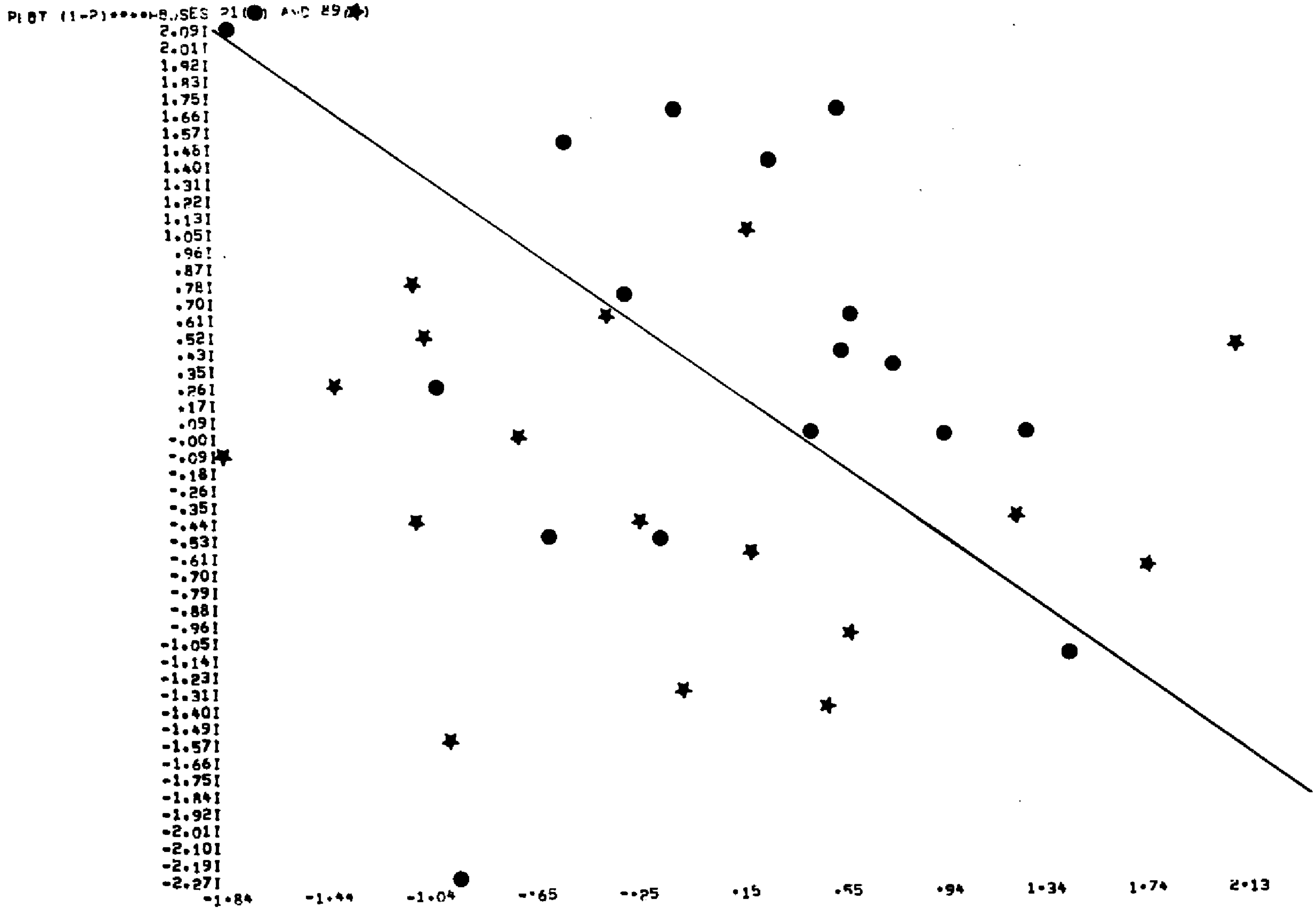

PLOT (1-2)****BUSES 21(●) AND 89(★)
2.09I
2.01I
1.92I
1.83I
1.75I
1.66I
1.57I
1.48I
1.40I
1.31I
1.22I
1.13I
1.05I
.96I
.87I
.78I
.70I
.61I
.52I
.43I
.35I
.26I
.17I
.09I
-.00I
-.09I
-.18I
-.26I
-.35I
-.44I
-.53I
-.61I
-.70I
-.79I
-.88I
-.96I
-1.05I
-1.14I
-1.23I
-1.31I
-1.40I
-1.49I
-1.57I
-1.66I
-1.75I
-1.84I
-1.92I
-2.01I
-2.10I
-2.19I
-2.27I
-1.84
-1.44
-1.04
-.65
-.25
.15
.55
.94
1.34
1.74
2.13

Fig. 106.

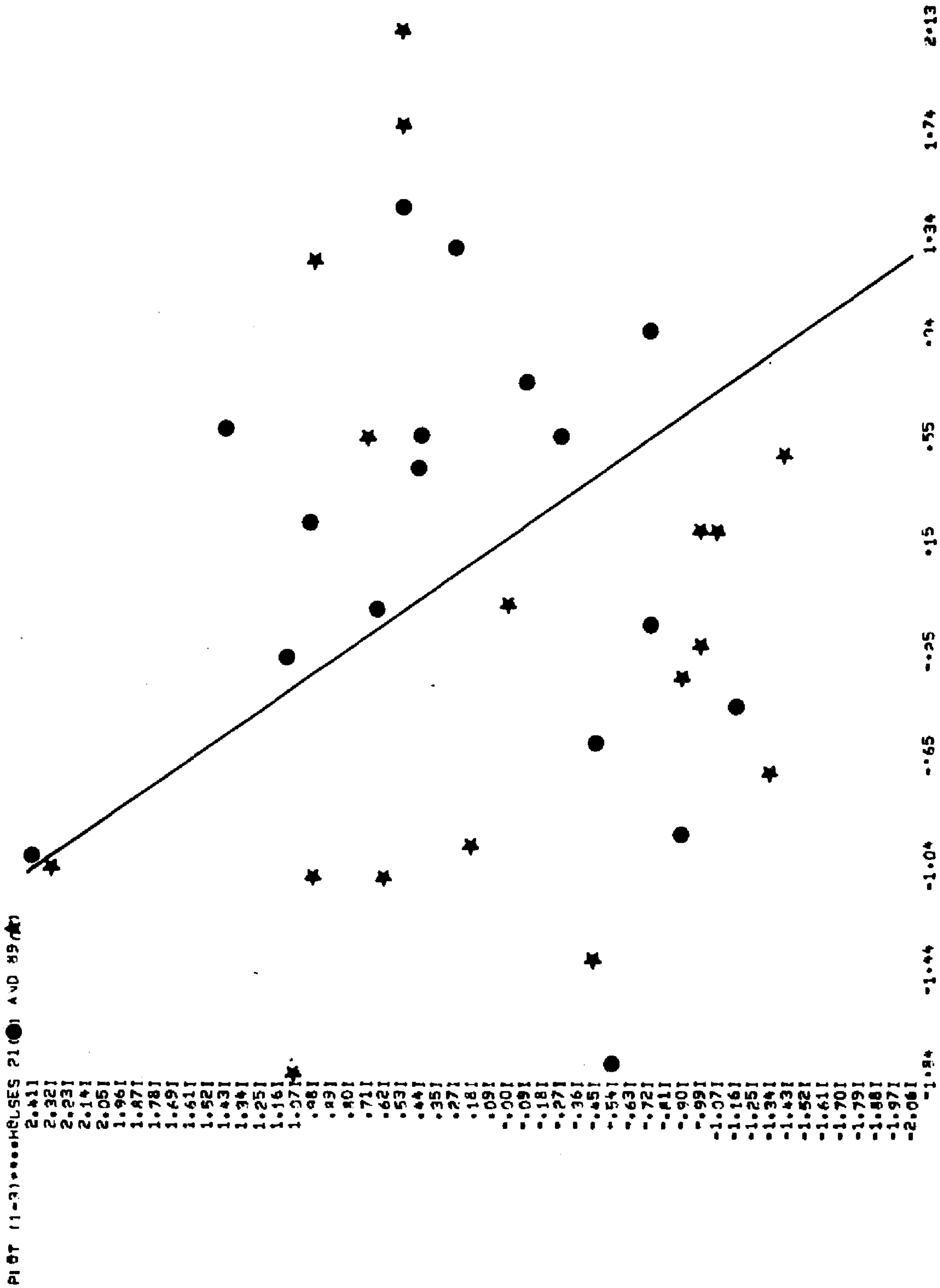


Fig. 107.

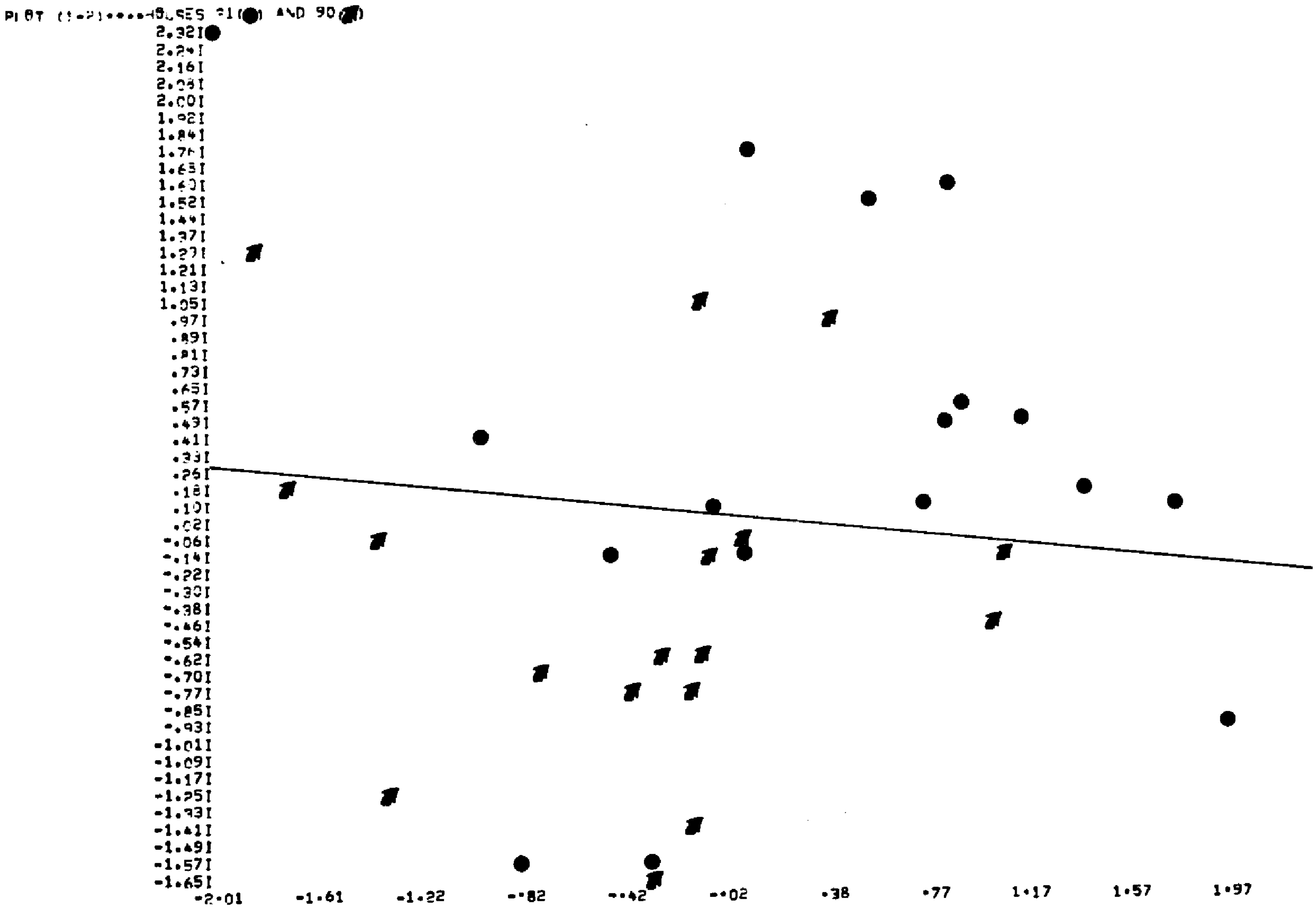

2.32I
2.16I
2.00I
1.84I
1.65I
1.52I
1.37I
1.21I
1.13I
1.05I
.97I
.89I
.73I
.65I
.57I
.49I
.41I
.18I
.10I
-.06I
-.14I
-.22I
-.30I
-.38I
-.46I
-.54I
-.62I
-.70I
-.77I
-.85I
-.93I
-1.01I
-1.09I
-1.17I
-1.25I
-1.33I
-1.41I
-1.49I
-1.57I
-1.65I
-2.01
-1.61
-1.22
-.82
-.42
-.02
.38
.77
1.17
1.57
1.97

Fig. 108.

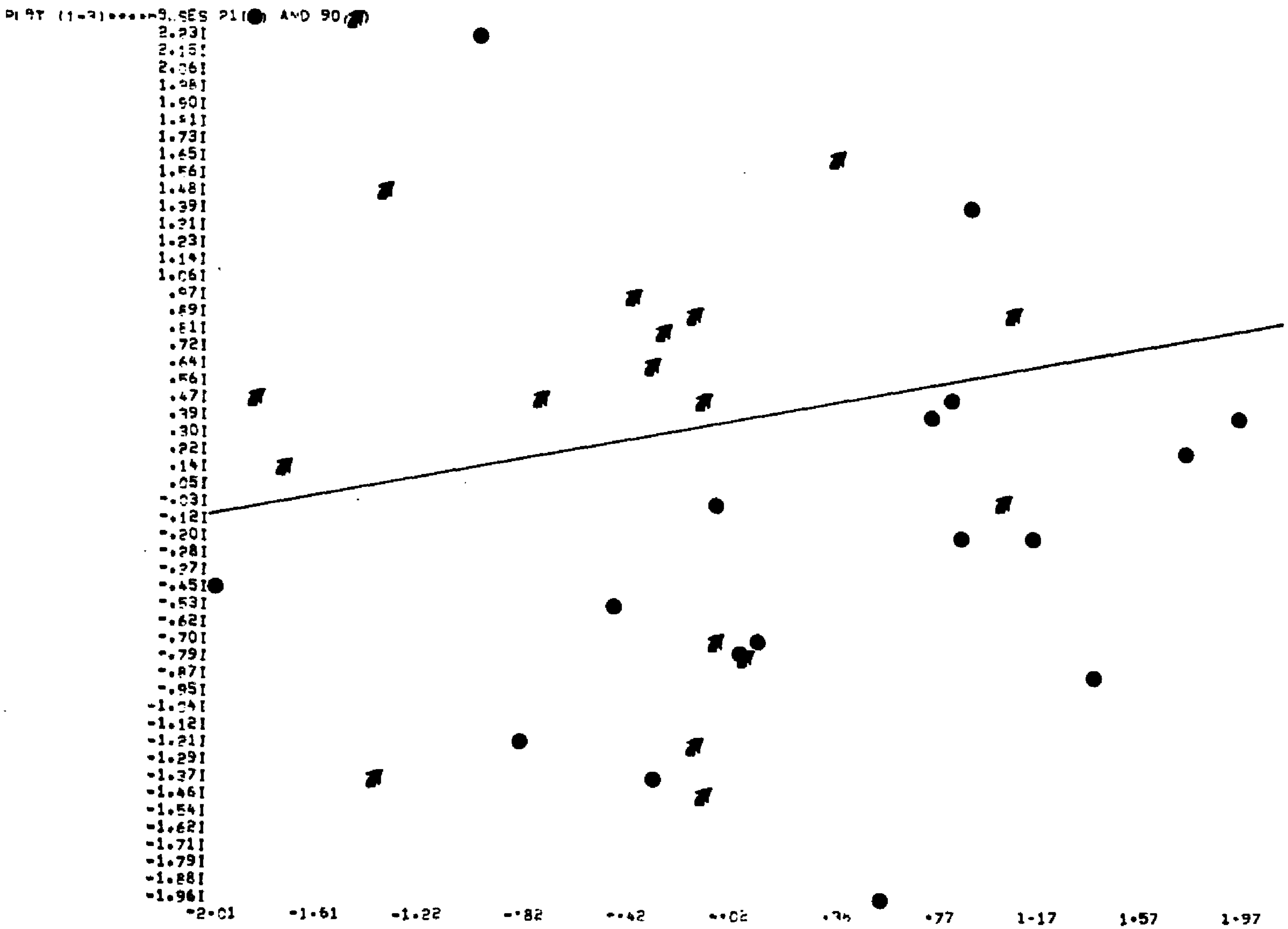


Fig. 109.

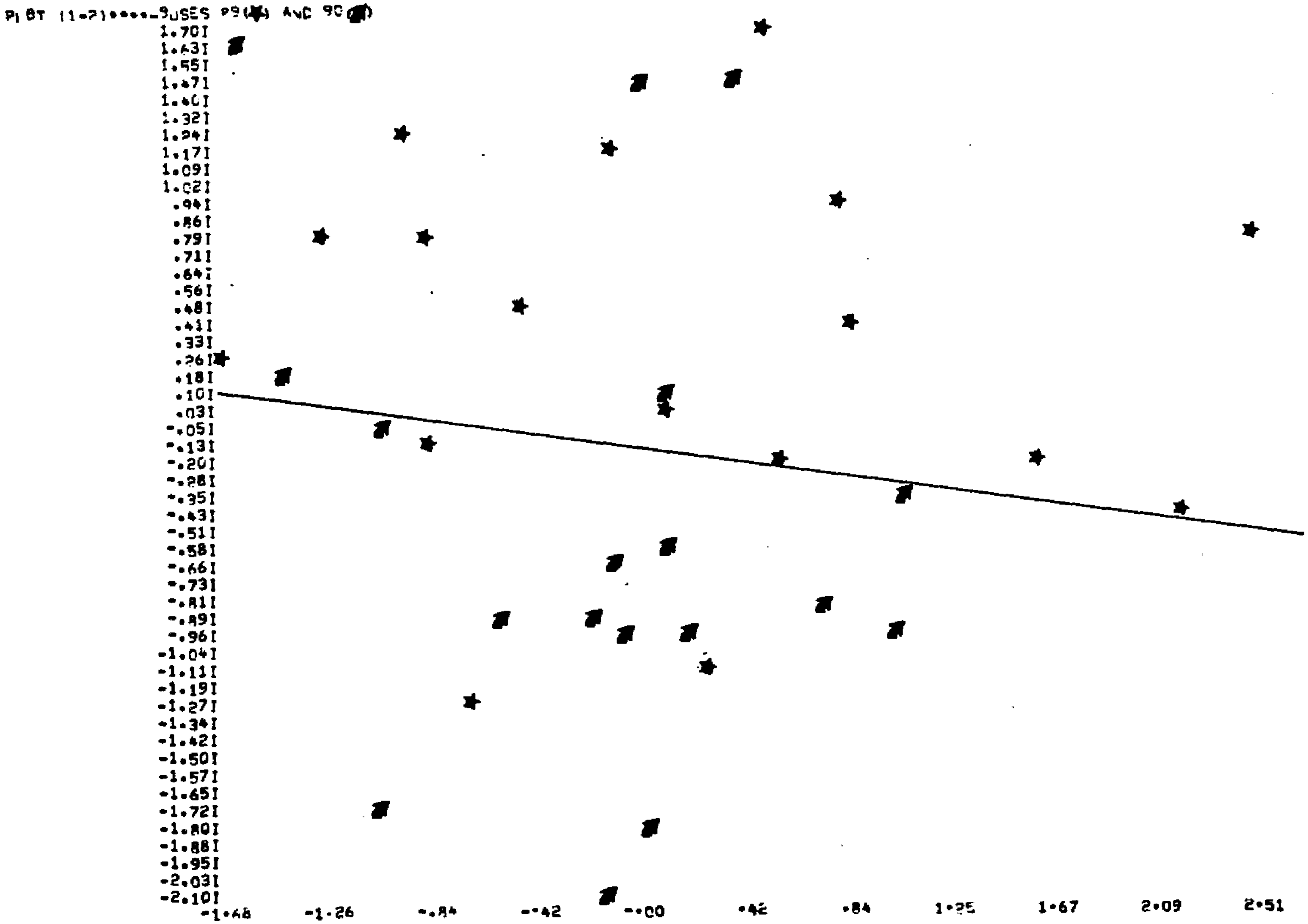

1.70
1.63
1.55
1.47
1.40
1.32
1.24
1.17
1.09
1.02
.94
.86
.79
.71
.64
.56
.48
.41
.33
.26
.18
.10
.03
-.05
-.13
-.20
-.28
-.35
-.43
-.51
-.58
-.66
-.73
-.81
-.89
-.96
-1.04
-1.11
-1.19
-1.27
-1.34
-1.42
-1.50
-1.57
-1.65
-1.72
-1.80
-1.88
-1.95
-2.03
-2.10
-1.68
-1.26
-.84
-.42
-.00
.42
.84
1.25
1.67
2.09
2.51

Fig. 110.

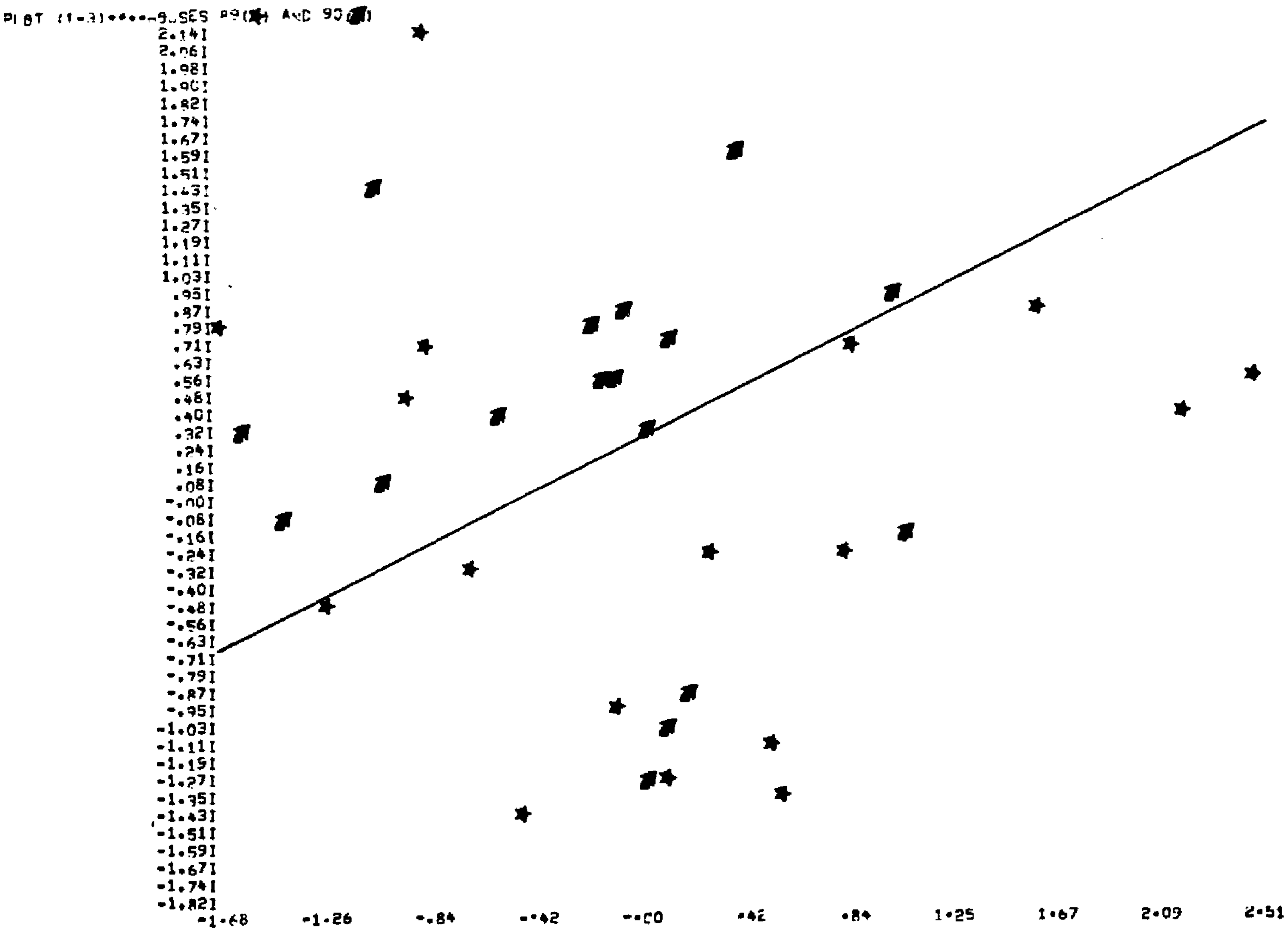


Fig. 111.

TABLE 17

NUMBER OF NON-DISTINCT PROFILES IN EACH COMPARISON

Pairwise Comparison	Components 1 and 2	Components 1 and 3
21-89	9	9
21-90	8	8
89-90	8	8

Components 1 and 3 again discriminate between households as well as Components 1 and 2. Interestingly, House 90, which was non-distinct in the analysis of Type 2 vessels, is distinct in this bowl form. The reasons for this difference are unclear.

In summary, it appears that Evans' hypothesis for ceramic specialization in the Balkans is not supported at this site. If Divostin can be viewed as a typical late Vinca settlement, then ceramic specialization was absent for these two bowl forms. The list of proposed specialized industries for the Balkans cannot at this time include Vinca bowls.

CHAPTER V

CONCLUSIONS

The results of the preceding analysis have been directed toward two questions: individual patterning in artifact production and ceramic specialization during the Late Neolithic of the Balkans.

Individual Patterning in Artifact Production

Observable differences among artisans who share a cultural template has been shown to be more than a sporadic and infrequent occurrence. In every case where the observer has taken the effort to carefully analyze the products of the artisans, clear differences emerge despite the shared cultural template. To be certain not every artisan can be distinguished, but distinctness appears to be the pattern. Each artisan maintains a unique style of artifact production, some with wider ranges of variation than others. It is this wider variation associated with some manufacturers which precludes identification of the author in all test cases. In the one case study, the Aluni, where a large number of artisans was observed, only two of the eight individuals were undistinguishable.

The reasons for the differences between individuals are numerous. They include differing individual interpretations of the cultural template (i.e. idiotemplates), slightly different methods of manufacture, differences in raw materials, variation in the skill or experience of the artisans, and at times a deliberate desire by the manufacturer to be slightly different from his fellow artisans. While no doubt additional sources of variation among artisans can be listed, it is sufficent to note at this time that there are enough sources of variability to produce distinct individual patterns. Thus, it becomes possible to test for the presence of individual manufacturers within a population of artifacts which appear relatively homogeneous.

This provides some insight into the variation encoutered within any one artifact type. As Thomas (1974:55) has noted: "Much of the so called 'typological variation' [within a single type] observable in prehistoric assemlages [may be] no more than variation between contempory craftsmen." Thus, it becomes possible to control one apparently major source of variation within an artifact type. Remaining variability can then be attributed to such other factors as temporal, spatial, or functional variation.

The accumulating body of evidense from a variety of ethnographic contexts shows that these differences are observable in a number of different mediums, including weaving (Gunn 1972, citing a personal communication from Adovosio), stone, ceramics, etc. The list of artifact classes will no doubt be greatly enlarged as the number of studies of this type increases. It is also encouraging to note that differences emerge even in simple flake tools. The diagnostic measures which distinguish one artisan from another may vary with the artifact type or class. Moreover, the same measures may not be appropriate within the same artifact class or type in two different cultures. The infancy of these studies has precluded retesting of measures from one study with new sets of data. The retesting is beginning, however. The same measures used at Jugtown to designate authorship were appropriate for the prehistoric materials from Divostin. Lewis (1974) is presently analyzing lithic materials using a trait list sensitive to authorship proposed by Gunn. The developemnt of these lists of traits which are sensitive to authorship is important so as to permit more efficient testing procedures in the future.

Authorship has been determined in societies spanning the range of socio-cultural development. Marshall (1957) has noted the manufacture of different projectile points by each hunter among the Kung Bushmen so as to permit identification of the successful archer. Similarly, individual differences are apparent in the ranked Aluni culture and in Jugtown, which is a small part of a state level society. This suggests that the causes of individual distinctness are independent of the level of socio-cultural development. The differences among artisans also appear to be independent of the producer/consumer relationship. In the material presented above, it was shown that producers who made artifacts for their own use, as the Aluni, were distinct. The Jugtown potters who distributed their ceramics in a market economy (and not even for their own use) were also distinct. This again directs attention to the personal causes of the individual variation in these craft industries.

The presence of individual differences is observed in similar classes of artifacts manufactured by different technologies. This is seen in the Jugtown ceramics, wheel made, and the Divostin bowl forms, hand made. Because of the fewer overlapping profiles in the Jugtown tests, it is apparent that the wheel made pottery is more distinct by author than the Divostin material. The greater distinctness in the wheel made pottery at Jugtown may be attributed to the smaller range of variaprehistoric materials from Divostin. Lewis (1974) is presently analyzing lithic materials using a trait list sensitive to authorship proposed by Gunn. The development of these lists of traits which are sensitive to authorship is important so as to permit more efficient testing procedures in the future.

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Ceramic Specialization in the Balkans

The presence of ceramic specialization within the Balkans during the Late Neolithic has been debated with varying results. The analysis of individual patterns of variation was proposed as a method of providing still another measure to "solve" the problem. The material analyzed from Divostin shows that ceramic production was located within each of the houses for the two bowl forms. That is, ceramic specialization was absent. This supports the position taken by Tringham who, on the basis of an absence of concentrations of pots and kilns, saw no evidence for ceramic specialization. Importantly. this analysis provides independent but complimentary lines of reasoning to support her arguments. On the other hand, the results would seem to negate Evans's assertion about ceramic specialization during this time period. He had suggested that ceramic specialization was present in the Gulmenitsa culture of Bulgaria. This was based upon the "complex" nature of the technology necessary for the production of the graphite wares. Ceramic specialization may have been present there, but not in central Jugoslavia, if the results from Divostin can be generalized to other Vinca sites. Evans could not find any evidence from other Late Neolithic cultures in the Balkans other than the Gulmenitsa to support his arguments.

As indicated in the introduction, the study of craft specialization can also be part of a measure which would allow the scaling of prehistoric societies along a continuum of craft specialization. Afterwards, evaluations like those of Narrol and Tatje can be attempted. In their study, the degree of craft specialization, as determined by the number of different specialists, served as one measure in ther scaling formula. The other measures, size of largest settlement and organizational ramification, are equally recoverable from the archaeological record.

More importantly, however, this analysis demonstrates that the recognition of individual differences and their study in space can be used to delineate systems of production that are household based. As yet there is no confirmation for the hypothesis that ceramic specialization can be identified by the lack of distinctness between units of comparison. This is a logical follow up to the analysis presented here. The testing of this hypothesis is crucial to studies concerned with idiosyncratic patterning and the reconstruction of systems of artifact production. Numerous ethnographic possibilities exist for this study, such as the Fulani in Africa or the village potters of Ouh in Indonesia. While this is a logical corollary to the notion of distinctness between units of comparison, there are a host of factors, such as multiple producers or borrowing or exchange, that might present the illusion of craft specialization when the pattern was in fact household.

Like many research programs, this analysis has suggested many more questions than it has answered. Studies are needed in contemporary communities where either household or specialized production is present. The contents of these households or similar activity areas can be analyzed to determine the system of production, if the system can be deduced despite the accumulation of material over a period of time. This remains one of the crucial areas to be considered. The analysis of the Divostin material suggests that household production can be observed though material has "theoretically" accumulated through time. While the analysis of contemporary communites cannot definitely answer the questions about prehistoric situations, they can provide a measure of reliability for the interpretations.

The use of the particular methodology and techniques need not be copied (though I hope they are for purposes of reevaluation), but the analysis suggests that much of the Late Neolithic of the Balkans is fertile ground for analyses of this type. The unusual pattern of burned villages (regardless of the cause) provides a laboratory where certain patterns of behavior have been fixed. The burned houses, as shown above, can be used as the units of comparison. Developmental questions, including those related to craft specialization, can be approached. The identification of authors within a population of similar artifacts can serve as a useful device to supplement our understanding of prehistoric societies.

APPENDIX A

AUTHORSHIP AND RAW DATA FOR VESSEL TYPES 2 AND 3

TYPE 2 VESSEL HOUSE 21 WITH HOUSE 89

RAY	1	2	3	4	5	6	7	8	9	10
21	220	235	250	265	280	280	280	275	260	250
21	240	250	270	280	290	290	295	295	290	290
21	220	230	235	240	240	245	250	250	245	240
21	230	250	265	275	280	280	275	275	275	270
21	240	255	270	275	285	290	290	290	285	280
21	225	235	245	255	260	260	260	250	250	245
21	220	230	240	245	250	250	255	255	255	255
21	210	215	220	220	225	230	230	230	220	215
21	210	220	220	225	230	235	235	240	240	230
21	215	225	235	245	255	270	285	280	280	280
21	215	220	230	240	245	255	260	255	250	250
21	215	225	230	240	240	235	230	220	210	205
21	210	215	220	225	230	230	235	240	240	235
21	210	225	235	245	260	265	270	270	270	270
21	230	250	270	285	290	290	290	280	270	260
21	220	220	220	220	220	220	215	215	210	210
21	220	235	245	260	270	270	270	270	270	265
89	210	220	230	235	240	250	255	255	250	240
89	230	260	275	285	290	290	285	280	280	280
89	220	225	230	230	230	230	225	220	195	200
89	220	225	245	250	255	255	250	240	235	230
89	220	235	245	250	260	255	250	245	240	230
89	220	235	245	255	260	270	280	270	270	260
89	230	240	245	255	260	265	260	260	250	250
89	220	230	240	250	260	260	255	250	250	250
89	220	235	245	250	260	260	260	250	245	240
89	210	210	215	220	220	220	210	200	195	190
89	225	240	250	255	255	250	250	245	240	240
89	205	210	210	210	215	215	215	215	210	210
89	210	220	230	240	245	250	250	250	240	230
89	195	220	230	230	235	235	230	220	210	200
89	230	235	240	240	240	235	230	230	220	220
89	210	220	225	230	230	230	225	220	220	215
89	230	240	250	250	255	255	255	250	245	240

TYPE 2 VESSEL HOUSE 21 WITH HOUSE 90

RAY	1	2	3	4	5	6	7	8	9	10
21	220	235	250	265	280	280	280	275	260	250
21	240	250	270	280	290	290	295	295	290	290
21	220	230	235	240	240	245	250	250	245	240
21	230	250	265	275	280	280	275	275	275	270
21	240	255	270	275	285	290	290	290	285	280
21	225	235	245	255	260	260	260	250	250	245
21	220	230	240	245	250	250	255	255	255	255
21	210	215	220	220	225	230	230	230	220	215
21	210	220	220	225	230	235	235	240	240	230
21	215	225	235	245	255	270	285	280	280	280
21	215	220	230	240	245	255	260	255	250	250
21	215	225	230	240	240	235	230	220	210	205
21	210	215	220	225	230	230	235	240	240	235
21	210	225	235	245	260	265	270	270	270	270
21	230	250	270	285	290	290	290	280	270	260
21	220	220	220	220	220	220	215	215	210	210
21	220	235	245	260	270	270	270	270	270	265
90	210	215	220	225	225	220	220	220	220	220
90	220	230	230	240	245	245	240	240	230	230
90	220	230	240	250	255	255	250	245	240	240
90	225	240	240	245	245	240	230	225	215	205
90	210	220	225	230	240	245	245	240	230	225
90	210	220	220	225	220	220	215	200	190	180
90	230	240	245	250	255	260	265	265	260	260
90	230	240	250	260	270	270	270	260	250	250
90	210	220	225	230	240	250	260	260	265	260
90	230	240	250	255	255	255	250	240	235	230
90	230	240	250	260	260	260	260	260	255	250
90	225	240	250	260	275	285	295	305	305	310
90	210	220	220	220	220	215	210	190	180	170
90	220	230	240	250	260	265	270	260	260	255
90	210	210	220	230	235	245	250	260	265	270
90	220	240	245	250	260	260	265	265	270	270
90	220	230	240	250	260	270	270	265	260	255

TYPE 2 VESSEL HOUSE 21 WITH HOUSE 91

RAY	1	2	3	4	5	6	7	8	9	10
21	220	235	250	265	280	280	280	275	260	250
21	240	250	270	280	290	290	295	295	290	290
21	220	230	235	240	240	245	250	250	245	240
21	230	250	265	275	280	280	275	275	275	270
21	240	255	270	275	285	290	290	290	285	280
21	225	235	245	255	260	260	260	250	250	245
21	220	230	240	245	250	250	255	255	255	255
21	210	215	220	220	225	230	230	230	220	215
21	210	220	220	225	230	235	235	240	240	230
21	215	225	235	245	255	270	285	280	280	280
21	215	220	230	240	245	255	260	255	250	250
21	215	225	230	240	240	235	230	220	210	205
21	210	215	220	225	230	230	235	240	240	235
21	210	225	235	245	260	265	270	270	270	270
21	230	250	270	285	290	290	290	280	270	260
21	220	220	220	220	220	220	215	215	210	210
21	220	235	245	260	270	270	270	270	270	265
91	225	240	250	260	275	280	285	280	280	275
91	230	245	250	260	275	280	285	290	290	295
91	230	250	260	280	285	290	290	285	285	285
91	215	225	240	245	250	245	240	235	230	230
91	225	245	260	270	280	285	290	290	290	290
91	230	250	270	280	290	300	305	300	300	280
91	230	240	250	260	260	265	260	250	250	240
91	225	230	235	240	245	250	250	250	240	235
91	225	240	250	265	270	275	275	270	270	270
91	230	245	255	260	265	270	270	265	260	260
91	230	245	255	260	265	270	270	270	260	260
91	225	235	245	250	260	260	255	250	245	240
91	220	230	240	250	260	260	265	270	270	260
91	230	240	250	260	270	270	260	250	245	240
91	225	240	250	260	270	275	270	260	260	260
91	230	235	245	250	250	250	250	250	245	240
91	235	250	260	275	285	290	295	295	290	290

TYPE 2 VESSEL HOUSE 21 WITH HOUSE 100

RAY	1	2	3	4	5	6	7	8	9	10
21	220	235	250	265	280	280	280	275	260	250
21	240	250	270	280	290	290	295	295	290	290
21	220	230	235	240	240	245	250	250	245	240
21	230	250	265	275	280	280	275	275	275	270
21	240	255	270	275	285	290	290	290	285	280
21	225	235	245	255	260	260	260	250	250	245
21	220	230	240	245	250	250	255	255	255	255
21	210	215	220	220	225	230	230	230	220	215
21	210	220	220	225	230	235	235	240	240	230
21	215	225	235	245	255	270	285	280	280	280
21	215	220	230	240	245	255	260	255	250	250
21	215	225	230	240	240	235	230	220	210	205
21	210	215	220	225	230	230	235	240	240	235
21	210	225	235	245	260	265	270	270	270	270
21	230	250	270	285	290	290	290	280	270	260
21	220	220	220	220	220	220	215	215	210	210
21	220	235	245	260	270	270	270	270	270	265
100	230	240	250	250	250	250	250	250	250	245
100	240	255	270	280	285	290	290	280	280	275
100	230	240	245	250	250	245	240	235	220	220
100	230	255	275	285	280	285	285	285	280	280
100	220	230	235	240	250	255	260	265	265	260
100	210	220	225	230	230	230	230	230	235	235
100	220	230	230	230	230	230	225	225	220	215
100	240	265	285	295	300	295	280	275	270	270
100	220	230	240	250	250	255	250	250	245	240
100	220	240	250	260	260	265	260	255	250	245
100	220	230	230	235	240	230	225	220	220	220
100	230	250	260	270	270	270	260	260	255	255
100	230	250	265	270	270	270	265	260	260	255
100	210	220	225	230	230	230	230	220	220	215
100	215	220	230	235	235	235	235	235	230	230
100	220	230	240	250	260	270	280	280	280	280
100	225	240	250	260	260	260	260	255	250	250

TYPE 2 VESSEL HOUSE 89 WITH HOUSE 90

RAY	1	2	3	4	5	6	7	8	9	10
89	210	220	230	235	240	250	255	255	250	240
89	230	260	275	285	290	290	285	280	280	280
89	220	225	230	230	230	230	225	220	195	200
89	220	225	245	250	255	255	250	240	235	230
89	220	235	245	250	260	255	250	245	240	230
89	220	235	245	255	260	270	280	270	270	260
89	230	240	245	255	260	265	260	260	250	250
89	220	230	240	250	260	260	255	250	250	250
89	220	235	245	250	260	260	260	250	245	240
89	210	210	215	220	220	220	210	200	195	190
89	225	240	250	255	255	250	250	245	240	240
89	205	210	210	210	215	215	215	215	210	210
89	210	220	230	240	245	250	250	250	240	230
89	195	220	230	230	235	235	230	220	210	200
89	230	235	240	240	240	235	230	230	220	220
89	210	220	225	230	230	230	225	220	220	215
89	230	240	250	250	255	255	255	250	245	240
90	210	215	220	225	225	220	220	220	220	220
90	220	230	230	240	245	245	240	240	230	230
90	220	230	240	250	255	255	250	245	240	240
90	225	240	240	245	245	240	230	225	215	205
90	210	220	225	230	240	245	245	240	230	225
90	210	220	220	225	220	220	215	200	190	180
90	230	240	245	250	255	260	265	265	260	260
90	230	240	250	260	270	270	270	260	250	250
90	210	220	225	230	240	250	260	260	265	260
90	230	240	250	255	255	255	250	240	235	230
90	230	240	250	260	260	260	260	260	255	250
90	225	240	250	260	275	285	295	305	305	310
90	210	220	220	220	220	215	210	190	180	170
90	220	230	240	250	260	265	270	260	260	255
90	210	210	220	230	235	245	250	260	265	270
90	220	240	245	250	260	260	265	265	270	270
90	220	230	240	250	260	270	270	265	260	255

TYPE 2 VESSEL HOUSE 89 WITH HOUSE 91

RAY	1	2	3	4	5	6	7	8	9	10
89	210	220	230	235	240	250	255	255	250	240
89	230	260	275	285	290	290	285	280	280	280
89	220	225	230	230	230	230	225	220	195	200
89	220	225	245	250	255	255	250	240	235	230
89	220	235	245	250	260	255	250	245	240	230
87	220	235	245	255	260	270	280	270	270	260
89	230	240	245	255	260	265	260	260	250	250
89	220	230	240	250	260	260	255	250	250	250
89	220	235	245	250	260	260	260	250	245	240
89	210	210	215	220	220	220	210	200	195	190
89	225	240	250	255	255	250	250	245	240	240
89	205	210	210	210	215	215	215	215	210	210
89	210	220	230	240	245	250	250	250	240	230
89	195	220	230	230	235	235	230	220	210	200
89	230	235	240	240	240	235	230	230	220	220
89	210	220	225	230	230	230	225	220	220	215
89	230	240	250	250	255	255	255	250	245	240
91	225	240	250	260	275	280	285	280	280	275
91	230	245	250	260	275	280	285	290	290	295
91	230	250	260	280	285	290	290	285	285	285
91	215	225	240	245	250	245	240	235	230	230
91	225	245	260	270	280	285	290	290	290	290
91	230	250	270	280	290	300	305	300	300	280
91	230	240	250	260	260	265	260	250	250	240
91	225	230	235	240	245	250	250	250	240	235
91	225	240	250	265	270	275	275	270	270	270
91	230	245	255	260	265	270	270	265	260	260
91	230	245	255	260	265	270	270	270	260	260
91	225	235	245	250	260	260	255	250	245	240
91	220	230	240	250	260	260	265	270	270	260
91	230	240	250	260	270	270	260	250	245	240
91	225	240	250	260	270	275	270	260	260	260
91	230	235	245	250	250	250	250	250	245	240
91	235	250	260	275	285	290	295	295	290	290

TYPE 2 VESSEL HOUSE 89 WITH HOUSE 100

RAY	1	2	3	4	5	6	7	8	9	10
89	210	220	230	235	240	250	255	255	250	240
89	230	260	275	285	290	290	285	280	280	280
89	220	225	230	230	230	230	225	220	195	200
89	220	225	245	250	255	255	250	240	235	230
89	220	235	245	250	260	255	250	245	240	230
89	220	235	245	255	260	270	280	270	270	260
89	230	240	245	255	260	265	260	260	250	250
89	220	230	240	250	260	260	255	250	250	250
89	220	235	245	250	260	260	260	250	245	240
89	210	210	215	220	220	220	210	200	195	190
89	225	240	250	255	255	250	250	245	240	240
89	205	210	210	210	215	215	215	215	210	210
89	210	220	230	240	245	250	250	250	240	230
89	195	220	230	230	235	235	230	220	210	200
89	230	235	240	24C	240	235	230	230	220	220
89	210	220	225	230	230	230	225	220	220	215
89	230	240	250	250	255	255	255	250	245	240
100	230	240	250	250	250	250	250	250	250	245
100	240	255	270	280	285	290	290	280	280	275
100	230	240	245	250	250	245	240	235	220	220
100	230	255	275	285	280	285	285	285	280	280
100	220	230	235	240	250	255	260	265	265	260
100	210	220	225	230	230	230	230	230	235	235
100	220	230	230	230	230	230	225	225	220	215
100	240	265	285	295	300	295	280	275	270	270
100	220	230	240	250	250	255	250	250	245	240
100	220	240	250	260	260	265	260	255	250	245
100	220	230	230	235	240	230	225	220	220	220
100	230	250	260	270	270	270	260	260	255	255
100	230	250	265	270	270	270	265	260	260	255
100	210	220	225	230	230	230	230	220	220	215
100	215	220	230	235	235	235	235	235	230	230
100	220	230	240	250	260	270	280	280	280	280
100	225	240	250	260	260	260	260	255	250	250

TYPE 2 VESSEL HOUSE 90 WITH HOUSE 100

RAY	1	2	3	4	5	6	7	8	9	10
90	210	215	220	225	225	220	220	220	220	220
90	220	230	230	240	245	245	240	240	230	230
90	220	230	240	250	255	255	250	245	240	240
90	225	240	240	245	245	240	230	225	215	205
90	210	220	225	230	240	245	245	240	230	225
90	210	220	220	225	220	220	215	200	190	180
90	230	240	245	250	255	260	265	265	260	260
90	230	240	250	260	270	270	270	260	250	250
90	210	220	225	230	240	250	260	260	265	260
90	230	240	250	255	255	255	250	240	235	230
90	230	240	250	260	260	260	260	260	255	250
90	225	240	250	260	275	285	295	305	305	310
90	210	220	220	220	220	215	210	190	180	170
90	220	230	240	250	260	265	270	260	260	255
90	210	210	220	230	235	245	250	260	265	270
90	220	240	245	250	260	260	265	265	270	270
90	220	230	240	250	260	270	270	265	260	255
100	230	240	250	250	250	250	250	250	250	245
100	240	255	270	280	285	290	290	280	280	275
100	230	240	245	250	250	245	240	235	220	220
100	230	255	275	285	280	285	285	285	280	280
100	220	230	235	240	250	255	260	265	265	260
100	210	220	225	230	230	230	230	230	235	235
100	220	230	230	230	230	230	225	225	220	215
100	240	265	285	295	300	295	280	275	270	270
100	220	230	240	250	250	255	250	250	245	240
100	220	240	250	260	260	265	260	255	250	245
100	220	230	230	235	240	230	225	220	220	220
100	230	250	260	270	270	270	260	260	255	255
100	230	250	265	270	270	270	265	260	260	255
100	210	220	225	230	230	230	230	220	220	215
100	215	220	230	235	235	235	235	235	230	230
100	220	230	240	250	260	270	280	280	280	280
100	225	240	250	260	260	260	260	255	250	250

TYPE 2 VESSEL HOUSE 90 WITH HOUSE 91

RAY	1	2	3	4	5	6	7	8	9	10
90	210	215	220	225	225	220	220	220	220	220
90	220	230	230	240	245	245	240	240	230	230
90	220	230	240	250	255	255	250	245	240	240
90	225	240	240	245	245	240	230	225	215	205
90	210	220	225	230	240	245	245	240	230	225
90	210	220	220	225	220	220	215	200	190	180
90	230	240	245	250	255	260	265	265	260	260
90	230	240	250	260	270	270	270	260	250	250
90	210	220	225	230	240	250	260	260	265	260
90	230	240	250	255	255	255	250	240	235	230
90	230	240	250	260	260	260	260	260	255	250
90	225	240	250	260	275	285	295	305	305	310
90	210	220	220	220	220	215	210	190	180	170
90	220	230	240	250	260	265	270	260	260	255
90	210	210	220	230	235	245	250	260	265	270
90	220	240	245	250	260	260	265	265	270	270
90	220	230	240	250	260	270	270	265	260	255
91	225	240	250	260	275	280	285	280	280	275
91	230	245	250	260	275	280	285	290	290	295
91	230	250	260	280	285	290	290	285	285	285
91	215	225	240	245	250	245	240	235	230	230
91	225	245	260	270	280	285	290	290	290	290
91	230	250	270	280	290	300	305	300	300	280
91	230	240	250	260	260	265	260	250	250	240
91	225	230	235	240	245	250	250	250	240	235
91	225	240	250	265	270	275	275	270	270	270
91	230	245	255	260	265	270	270	265	260	260
91	230	245	255	260	265	270	270	270	260	260
91	225	235	245	250	260	260	255	250	245	240
91	220	230	240	250	260	260	265	270	270	260
91	230	240	250	260	270	270	260	250	245	240
91	225	240	250	260	270	275	270	260	260	260
91	230	235	245	250	250	250	250	250	245	240
91	235	250	260	275	285	290	295	295	290	290

TYPE 2 VESSEL HOUSE 91 WITH HOUSE 100

RAY	1	2	3	4	5	6	7	8	9	10
91	225	240	250	260	275	280	285	280	280	275
91	230	245	250	260	275	280	285	290	290	275
91	230	250	260	280	285	290	290	285	285	285
91	215	225	240	245	250	245	240	235	230	230
91	225	245	260	270	280	285	290	290	290	290
91	230	250	270	280	290	300	305	300	300	280
91	230	240	250	260	260	265	260	250	250	240
91	225	230	235	240	245	250	250	250	240	235
91	225	240	250	265	270	275	275	270	270	270
91	230	245	255	260	265	270	270	265	260	260
91	230	245	255	260	265	270	270	270	260	260
91	225	235	245	250	260	260	255	250	245	240
91	220	230	240	250	260	260	265	270	270	260
91	230	240	250	260	270	270	260	250	245	240
91	225	240	250	260	270	275	270	260	260	260
91	230	235	245	250	250	250	250	250	245	240
91	235	250	260	275	285	290	295	295	290	290
100	230	240	250	250	250	250	250	250	250	245
100	240	255	270	280	285	290	290	280	280	275
100	230	240	245	250	250	245	240	225	220	220
100	230	255	275	285	280	285	285	285	280	290
100	220	230	235	240	250	255	260	265	265	260
100	210	220	225	230	230	230	230	230	235	235
100	220	230	230	230	230	230	225	225	220	215
100	240	265	285	295	300	295	280	275	270	270
100	220	230	240	250	250	255	250	250	245	240
100	225	240	250	260	260	265	260	255	250	245
100	220	230	230	235	240	230	225	220	220	220
100	230	250	260	270	270	270	260	260	255	255
100	230	250	265	270	270	270	265	260	260	255
100	210	220	225	230	230	230	230	220	220	215
100	215	220	230	235	235	235	235	235	230	230
100	220	230	240	250	260	270	280	280	280	280
100	225	240	250	260	260	260	260	255	250	250

TYPE 3 VESSEL HOUSE 21 WITH HOUSE 89

RAY	1	2	3	4	5	6	7	8	9	10
21	210	210	215	215	220	250	280	285	295	300
21	215	215	230	250	280	295	300	305	310	315
21	210	210	215	215	225	250	280	300	315	335
21	210	220	225	230	255	300	325	340	360	370
21	220	225	225	220	220	250	280	310	350	370
21	195	200	200	200	195	210	230	250	270	285
21	210	220	220	225	235	280	320	355	380	390
21	210	215	220	225	240	265	290	310	325	330
21	215	225	235	240	280	330	360	370	370	375
21	200	200	195	195	200	230	250	270	285	290
21	220	230	235	235	230	230	235	240	255	290
21	220	230	235	240	250	300	330	350	370	390
21	210	210	215	220	260	330	360	375	390	400
21	220	230	230	235	240	255	300	325	340	350
21	215	220	225	230	255	290	325	355	375	390
21	215	220	220	230	265	320	350	375	395	405
21	220	220	220	230	275	300	330	355	360	370
89	215	220	230	235	245	265	280	290	290	295
89	210	215	220	225	270	330	370	395	415	425
89	210	215	230	260	285	310	330	340	340	340
89	215	215	220	225	230	250	260	260	265	270
89	215	215	220	220	250	275	300	315	325	335
89	210	215	215	215	215	220	240	270	295	320
89	220	220	225	230	230	260	305	330	350	355
89	205	205	210	220	235	250	280	310	325	345
89	210	220	220	230	280	320	365	380	395	400
89	215	225	230	240	270	350	400	420	440	445
89	215	220	230	250	280	300	300	305	310	310
89	210	210	220	230	245	260	280	280	290	290
89	210	220	230	235	260	300	330	355	375	380
89	215	220	220	225	225	250	280	300	320	325
89	215	220	225	230	250	280	320	340	355	385
89	210	220	220	220	225	230	240	260	270	270
89	210	210	215	215	220	235	270	300	320	330

TYPE 3 VESSEL HOUSE 89 WITH HOUSE 90

RAY	1	2	3	4	5	6	7	8	9	10
89	215	220	230	235	245	265	280	290	290	295
89	210	215	220	225	270	330	370	395	415	425
89	210	215	230	260	285	310	330	340	340	340
89	215	215	220	225	230	250	260	260	265	270
89	215	215	220	220	250	275	300	315	325	335
89	210	215	215	215	215	220	240	270	295	320
89	220	220	225	230	230	260	305	330	350	355
89	205	205	210	220	235	250	280	310	325	345
89	210	220	220	230	280	320	365	380	395	400
89	215	225	230	240	270	350	400	420	440	445
89	215	220	230	250	280	300	300	305	310	310
89	210	210	220	230	245	260	280	280	290	290
89	210	220	230	235	260	300	330	355	375	380
89	215	220	220	225	225	250	280	300	320	325
89	215	220	225	230	250	280	320	340	355	385
89	210	220	220	220	225	230	240	260	270	270
89	210	210	215	215	220	235	270	300	320	330
90	210	210	210	210	220	230	260	275	280	285
90	215	210	210	210	230	270	280	290	310	315
90	205	210	210	220	240	260	275	280	290	295
90	205	210	215	225	255	280	300	310	315	325
90	210	220	225	230	270	320	350	360	370	375
90	200	200	200	205	205	225	250	280	300	315
90	220	220	230	235	260	285	305	320	335	340
90	210	210	220	220	225	240	250	250	250	260
90	200	205	210	225	250	260	270	270	270	275
90	220	225	230	255	280	320	345	360	360	365
90	215	225	230	230	240	250	265	260	260	260
90	200	200	205	220	240	260	280	295	310	310
90	210	205	210	230	255	275	290	300	310	320
90	210	210	215	220	225	240	280	310	320	335
90	210	210	220	220	250	285	325	350	360	370
90	210	210	205	205	205	210	230	245	255	260
90	210	210	210	225	255	280	300	305	310	315

TYPE 3 VESSEL HOUSE 21 WITH HOUSE 90

RAY	1	2	3	4	5	6	7	8	9	10
21	210	210	215	215	220	250	280	285	295	300
21	215	215	230	250	280	295	300	305	310	315
21	210	210	215	215	225	250	280	300	315	335
21	210	220	225	230	255	300	325	340	360	370
21	220	225	225	220	220	250	280	310	350	370
21	195	200	200	200	195	210	230	250	270	285
21	210	220	220	225	235	280	320	355	380	390
21	210	215	220	225	240	265	290	310	325	330
21	215	225	235	240	280	330	360	370	370	375
21	200	200	195	195	200	230	250	270	285	290
21	220	230	235	235	230	230	235	240	255	290
21	220	230	235	240	250	300	330	350	370	390
21	210	210	215	220	260	330	360	375	390	400
21	220	230	230	235	240	255	300	325	340	350
21	215	220	225	230	255	290	325	355	375	390
21	215	220	220	230	265	320	350	375	395	405
21	220	220	220	230	275	300	330	355	360	370
90	210	210	220	220	250	285	325	350	360	370
90	210	210	205	205	205	210	230	245	255	260
90	210	210	210	225	255	280	300	305	310	315
90	210	210	210	210	220	230	260	275	280	285
90	215	210	210	210	230	270	280	290	310	315
90	205	210	210	220	240	260	275	280	290	295
90	205	210	215	225	255	280	300	310	315	325
90	210	220	225	230	270	320	350	360	370	375
90	200	200	200	205	205	225	250	280	300	315
90	220	220	230	235	260	285	305	320	335	340
90	210	210	220	220	225	240	250	250	250	260
90	200	205	210	225	250	260	270	270	270	275
90	220	225	230	255	280	320	345	360	360	365
90	215	225	230	230	240	250	265	260	260	260
90	200	200	205	220	240	260	280	295	310	310
90	210	205	210	230	255	275	290	300	310	320
90	210	210	215	220	225	240	280	310	320	335

APPENDIX B

PRINCIPAL COMPONENTS DATA FOR THE JUGTOWN POTTERY

TABLE 31

JUGTOWN POTTERS A AND B (RIGHT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	14.24333	75.0	75.0
2	3.04724	16.0	91.0
3	.71207	3.7	94.8

TABLE 32

JUGTOWN POTTERS A AND B (RIGHT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.92360	-.20299	-.17554
2	.87572	-.43514	.13904
3	.93698	-.12751	-.18282
4	.91708	-.25923	-.16110
5	.92189	-.18805	-.24024
6	.95760	-.09875	-.23347
7	.96455	.03287	-.22463
8	.91613	.22436	-.25580
9	.74596	.57520	-.23572
10	.35630	.87576	-.02468
11	.52803	.74082	.10333
12	.81395	.51469	.19564
13	.85934	.39645	.21740
14	.89481	.28927	.23750
15	.95906	.01191	.21336
16	.94596	-.17612	.21274
17	.88370	-.40862	.17498
18	.89848	-.36501	.15508
19	.89510	-.39111	.14206

TABLE 33

JUGTOWN POTTERS A AND B (LEFT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	13.47371	70.9	70.9
2	2.17993	11.5	82.4
3	1.86280	9.8	92.2

TABLE 34

JUGTOWN POTTERS A AND B (LEFT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.93990	-.18746	-.03437
2	.93878	.06424	-.26883
3	.86819	-.31606	.06075
4	.88540	-.33838	-.00861
5	.91283	-.34582	.00903
6	.91776	-.32685	.12566
7	.92169	-.31421	.14648
8	.85098	-.32947	.36048
9	.74897	-.19910	.56836
10	.05005	.12658	.90639
11	.37421	.80796	.24779
12	.68716	.56571	.30427
13	.85348	.39959	.09014
14	.88586	.38169	-.06754
15	.90316	.29624	-.13716
16	.88505	.24630	-.24046
17	.94131	.06171	-.28010
18	.93120	.05092	-.28083
19	.93863	.06098	-.27045

TABLE 35

JUGTOWN POTTERS A AND C (RIGHT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.70647	45.8	45.8
2	4.31737	22.7	68.5
3	1.96474	10.3	78.9

TABLE 36

JUGTOWN POTTERS A AND C (RIGHT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.66472	.33767	-.11397
2	.71817	-.46984	-.23190
3	.58548	.52324	.21619
4	.43348	.45442	-.42407
5	.58799	.45827	-.28582
6	.35709	.74425	-.43886
7	.35709	.74425	-.43886
8	.02515	.78878	-.02489
9	-.38203	.78741	.07969
10	-.21164	.68509	.49050
11	.53431	.34339	.62355
12	.83688	.04009	.40528
13	.86560	.12821	.36290
14	.85318	-.07235	.34696
15	.94661	-.09251	.05618
16	.93112	-.15936	.12318
17	.85628	-.38008	.16566
18	.85248	-.23698	-.25054
19	.86026	-.31180	-.20808

TABLE 37

JUGTOWN POTTERS A AND C (LEFT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	7.29905	38.4	38.4
2	5.19037	27.3	65.7
3	2.85256	15.0	80.7

TABLE 38

JUGTOWN POTTERS A AND C (LEFT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.57778	.37677	-.28476
2	.78230	-.18779	-.36612
3	.19403	.72540	.06730
4	.33342	.78034	-.16582
5	.42000	.70913	-.35556
6	.46705	.81480	-.03130
7	.38286	.85251	.04920
8	-.00973	.91659	.24697
9	-.23217	.70895	.52452
10	-.37100	.53873	.64335
11	.49496	-.35551	.63304
12	.59749	-.23368	.62400
13	.70602	-.19364	.55983
14	.78685	-.25214	.49486
15	.86018	-.12489	.24981
16	.81861	-.17436	.16300
17	.91979	-.02406	-.28183
18	.85657	-.07764	-.32758
19	.87314	-.13012	-.31856

TABLE 39

JUGTOWN POTTERS B AND C (RIGHT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	13.09686	68.9	68.9
2	3.70316	19.5	88.4
3	1.10937	5.8	94.3

TABLE 40

JUGTOWN POTTERS B AND C (RIGHT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.90559	-.23341	-.25076
2	.80210	-.42715	.28093
3	.90787	-.28012	-.20936
4	.89469	-.34586	-.08553
5	.89346	-.26873	-.22716
6	.94244	-.21417	-.19519
7	.95957	-.07748	-.22054
8	.94039	.06538	-.28369
9	.88707	.26804	-.33214
10	.59336	.65975	-.29082
11	.32332	.88701	.07937
12	.54231	.80710	.13031
13	.69543	.67727	.09469
14	.77989	.54326	.19269
15	.88085	.26505	.32820
16	.91868	.00606	.33526
17	.85919	-.37482	.30220
18	.87082	-.33144	.23944
19	.87823	-.34644	.25409

TABLE 41

JUGTOWN POTTERS B AND C (LEFT PROFILES)
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	13.92193	73.3	73.3
2	2.44840	12.9	86.2
3	1.13910	6.0	92.2

TABLE 42

JUGTOWN POTTERS B AND C (LEFT PROFILES)
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.91483	-.18234	.18956
2	.88891	-.11322	-.32185
3	.89439	-.30374	.11078
4	.92336	-.31729	-.00085
5	.90345	-.30135	.03388
6	.92815	-.28248	.13263
7	.95029	-.21141	.14378
8	.92835	-.15845	.28443
9	.90487	-.02011	.36767
10	.68240	.24527	.53943
11	.13296	.91854	.01669
12	.56388	.74726	.17469
13	.80944	.48369	.06681
14	.83850	.41851	-.16186
15	.86504	.28400	-.26998
16	.93114	.11465	-.24192
17	.92936	-.05460	-.30401
18	.93670	-.00229	-.25418
19	.93003	-.02164	-.30156

APPENDIX C

PRINCIPAL COMPONENTS DATA FOR TYPE 2 VESSELS

TABLE 43

TYPE 2 VESSELS: HOUSES 21 AND 89
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	6.39466	63.9	63.9
2	2.32358	23.2	87.2
3	.86124	8.6	95.8

TABLE 44

TYPE 2 VESSELS: HOUSES 21 AND 89
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.54804	.68036	.34296
2	.63783	.62832	.37084
3	.69440	.68189	-.03631
4	.71599	.51806	-.41344
5	.85963	.04317	-.46487
6	.92392	-.24196	-.23141
7	.92796	-.34611	-.03994
8	.90071	-.41483	.09657
9	.85866	-.44739	.22806
10	.83091	-.42439	.31822

TABLE 45

TYPE 2 VESSELS: HOUSES 21 AND 90
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	6.67766	66.8	66.8
2	2.07368	20.7	87.5
3	.85850	8.6	96.1

TABLE 46

TYPE 2 VESSELS: HOUSES 21 AND 90
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.65956	.59310	.32477
2	.70007	.59876	.32508
3	.72976	.64788	.02057
4	.74979	.45903	-.40682
5	.85417	.03084	-.49295
6	.91449	-.25376	-.24618
7	.93019	-.33548	-.06923
8	.89986	-.41451	.09120
9	.85113	-.45610	.24051
10	.83218	-.41861	.32690

TABLE 47

TYPE 2 VESSELS: HOUSES 21 AND 91
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.67351	86.7	86.7
2	.94176	9.4	96.2
3	.24230	2.4	98.6

TABLE 48

TYPE 2 VESSELS: HOUSES 21 AND 91
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.78665	.52668	.30635
2	.92906	.33528	.05833
3	.94580	.28403	-.08314
4	.95849	.19420	-.18066
5	.97356	.05694	-.19179
6	.98294	-.05071	-.12839
7	.96558	-.22071	-.05607
8	.94153	-.30876	.06648
9	.91916	-.36659	.10694
10	.89369	-.38642	.18230

TABLE 49

TYPE 2 VESSELS: HOUSES 21 AND 100
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.52526	85.3	85.3
2	1.15798	11.6	96.8
3	.18800	1.9	98.7

TABLE 50

TYPE 2 VESSELS: HOUSES 21 AND 100
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.81209	.49379	.28344
2	.88645	.44113	.03551
3	.93962	.32236	-.03882
4	.95543	.23659	-.15485
5	.97634	.08731	-.16075
6	.98559	-.07352	-.12409
7	.94847	-.27958	-.06136
8	.92979	-.35107	.02959
9	.89840	-.41597	.10773
10	.88794	-.41496	.15307

TABLE 51

TYPE 2 VESSELS: HOUSES 89 AND 90
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.14312	81.4	81.4
2	1.37785	13.8	95.2
3	.28338	2.8	98.0

TABLE 52

TYPE 2 VESSELS: HOUSES 89 AND 90
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.73501	.53026	.40880
2	.83826	.49882	-.01588
3	.90371	.38123	-.13885
4	.94574	.26689	-.13078
5	.97574	.09251	-.15340
6	.97550	-.11374	-.12211
7	.94824	-.27413	-.05453
8	.91781	-.37542	.07852
9	.88403	.44751	.07975
10	.87312	-.43982	.16027

TABLE 53

TYPE 2 VESSELS: HOUSES 89 AND 91
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.90448	89.0	89.0
2	.67625	6.8	95.8
3	.25865	2.6	98.4

TABLE 54

TYPE 2 VESSELS: HOUSES 89 AND 91
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.77185	.54497	.31799
2	.93621	.29358	-.06504
3	.94313	.22100	-.21611
4	.97308	.10426	-.16841
5	.98124	-.00716	-.13655
6	.98279	-.10368	-.07518
7	.97170	-.20769	.01341
8	.95710	-.23456	.12830
9	.94939	-.27938	.10895
10	.95163	-.21531	.15948

TABLE 55

TYPE 2 VESSELS: HOUSES 89 AND 100
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.72463	87.2	87.2
2	.86871	8.7	95.9
3	.24843	2.5	98.4

TABLE 56

TYPE 2 VESSELS: HOUSES 89 AND 100
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.79254	.48457	.35782
2	.91681	.36119	-.02040
3	.94608	.27102	-.13790
4	.96719	.17867	-.15054
5	.97636	.08815	-.15111
6	.98141	-.08383	-.12297
7	.95481	-.25933	-.02788
8	.94411	-.29769	.07367
9	.91741	-.36829	.10078
10	.92972	-.30294	.15489

TABLE 57

TYPE 2 VESSELS: HOUSES 90 AND 91
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.44851	84.5	84.5
2	1.21305	12.1	96.6
3	.17272	1.7	98.3

TABLE 58

TYPE 2 VESSELS: HOUSES 90 AND 91
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.79554	.52177	.28592
2	.87042	.44838	.03292
3	.92896	.32946	-.08561
4	.95277	.23940	-.12365
5	.98078	.06073	-.14605
6	.98261	-.07184	-.11904
7	.96377	-.23079	-.05543
8	.92801	-.35303	.08562
9	.89956	-.42292	.07126
10	.87209	-.45640	.12762

TABLE 59

TYPE 2 VESSELS: HOUSES 90 AND 100
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.15875	81.6	81.6
2	1.54038	15.4	97.0
3	.14282	1.4	98.4

TABLE 60

TYPE 2 VESSELS: HOUSES 90 AND 100
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.81773	.49182	.27070
2	.84617	.50623	.03942
3	.91126	.38506	.05432
4	.93685	.30638	.11658
5	.97888	.12628	.10631
6	.98216	.07503	.12966
7	.93975	.29635	.06667
8	.90421	.41586	.05121
9	.85756	.49996	.07812
10	.84083	.51747	.10082

TABLE 61

TYPE 2 VESSELS: HOUSES 91 AND 100
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	8.50324	85.0	85.0
2	1.11099	11.1	96.1
3	.21103	2.1	98.3

TABLE 62

TYPE 2 VESSELS: HOUSES 91 AND 100
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.79061	.49477	.35541
2	.89959	.40451	.00195
3	.91557	.34570	-.14957
4	.94889	.23550	-.18593
5	.97865	.06839	-.10156
6	.98553	-.06027	-.06455
7	.95773	-.25842	.01836
8	.93000	-.34174	.08338
9	.90390	-.41229	.05205
10	.89559	-.40711	.05745

APPENDIX D

PLOTS OF RANDOM POINTS

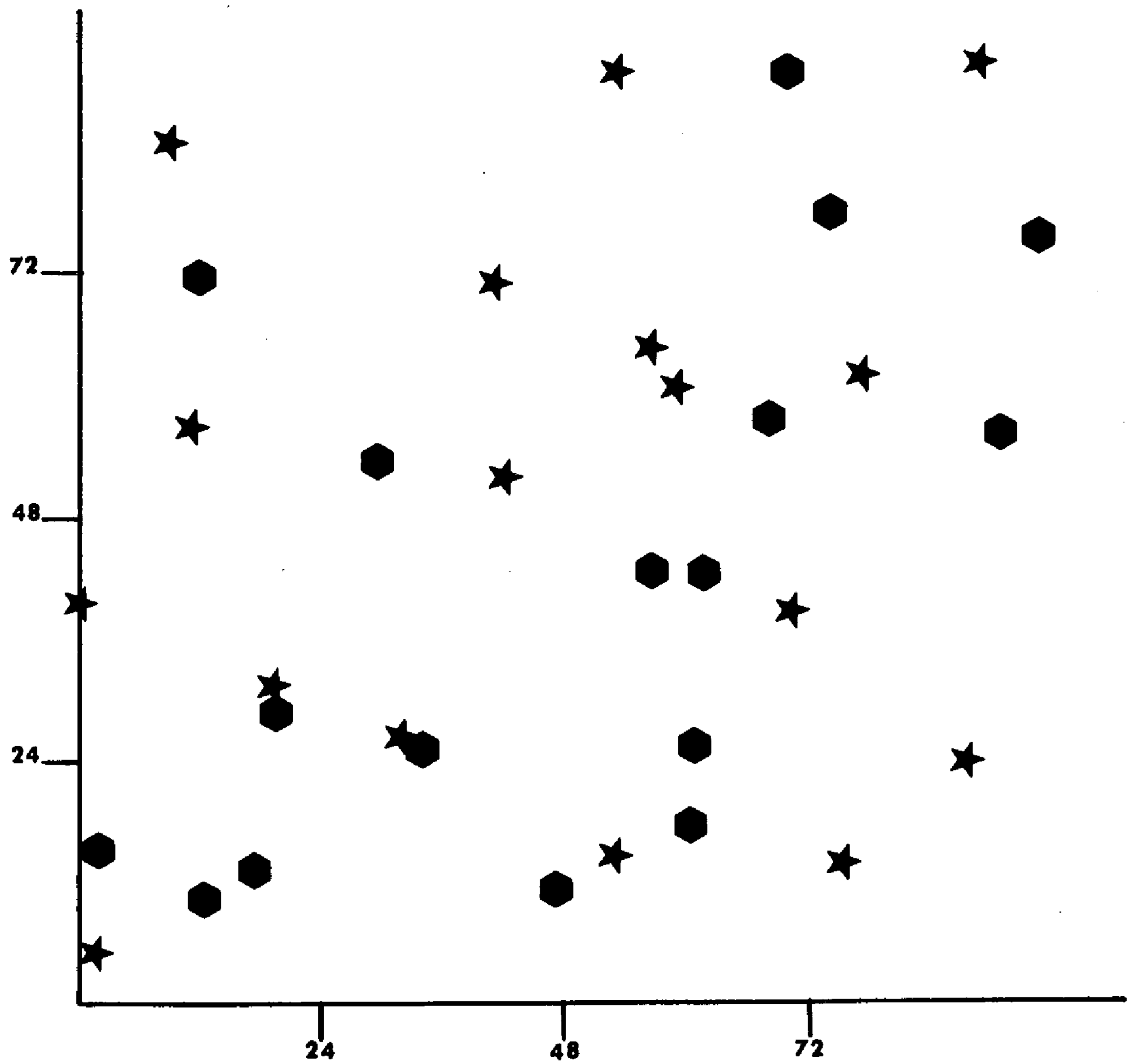

Fig. 112. Random Points Test No. 1.

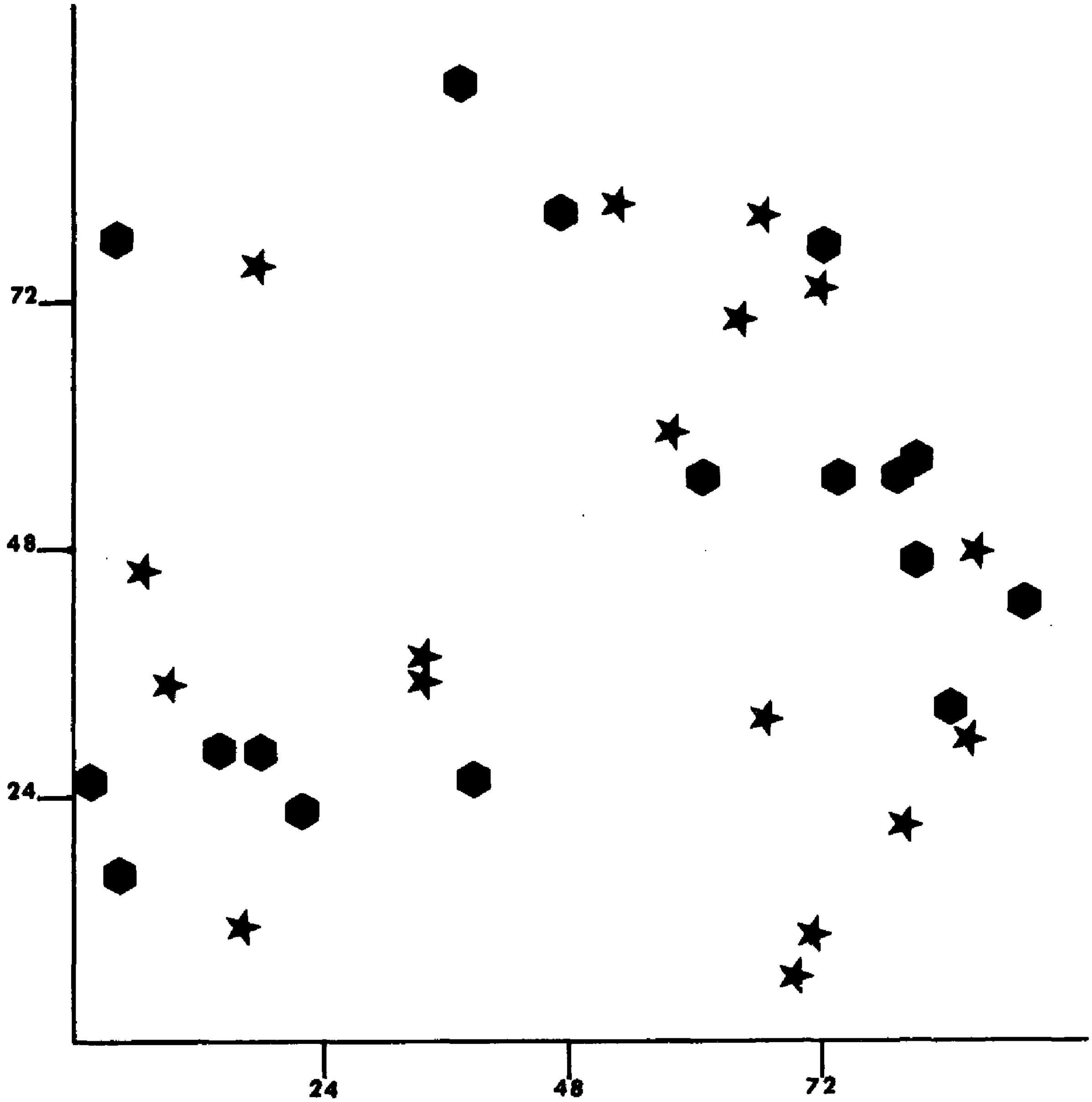

Fig. 113. Random Points Test No. 2.

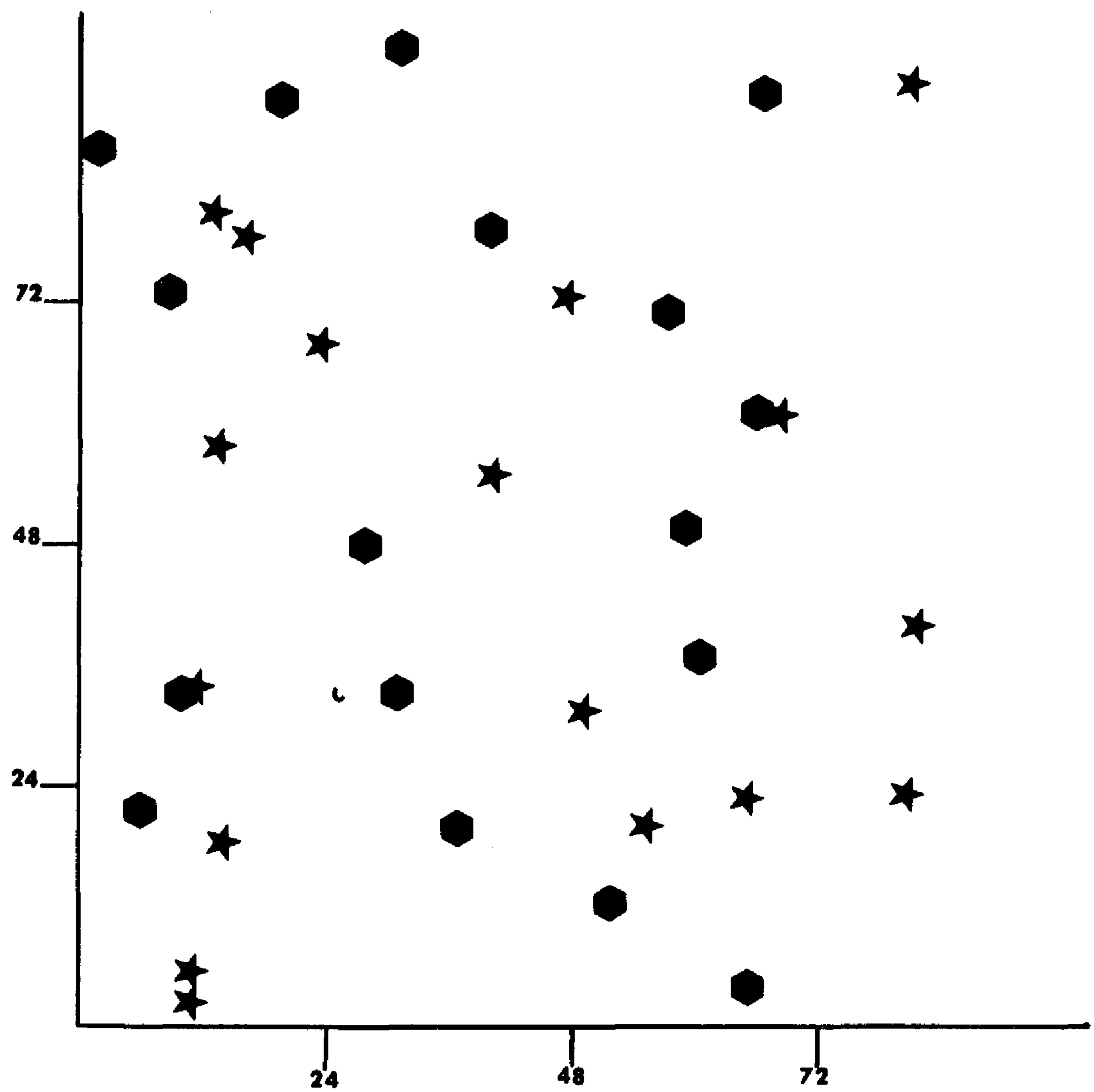

Fig. 114. Random Points Test No. 3.

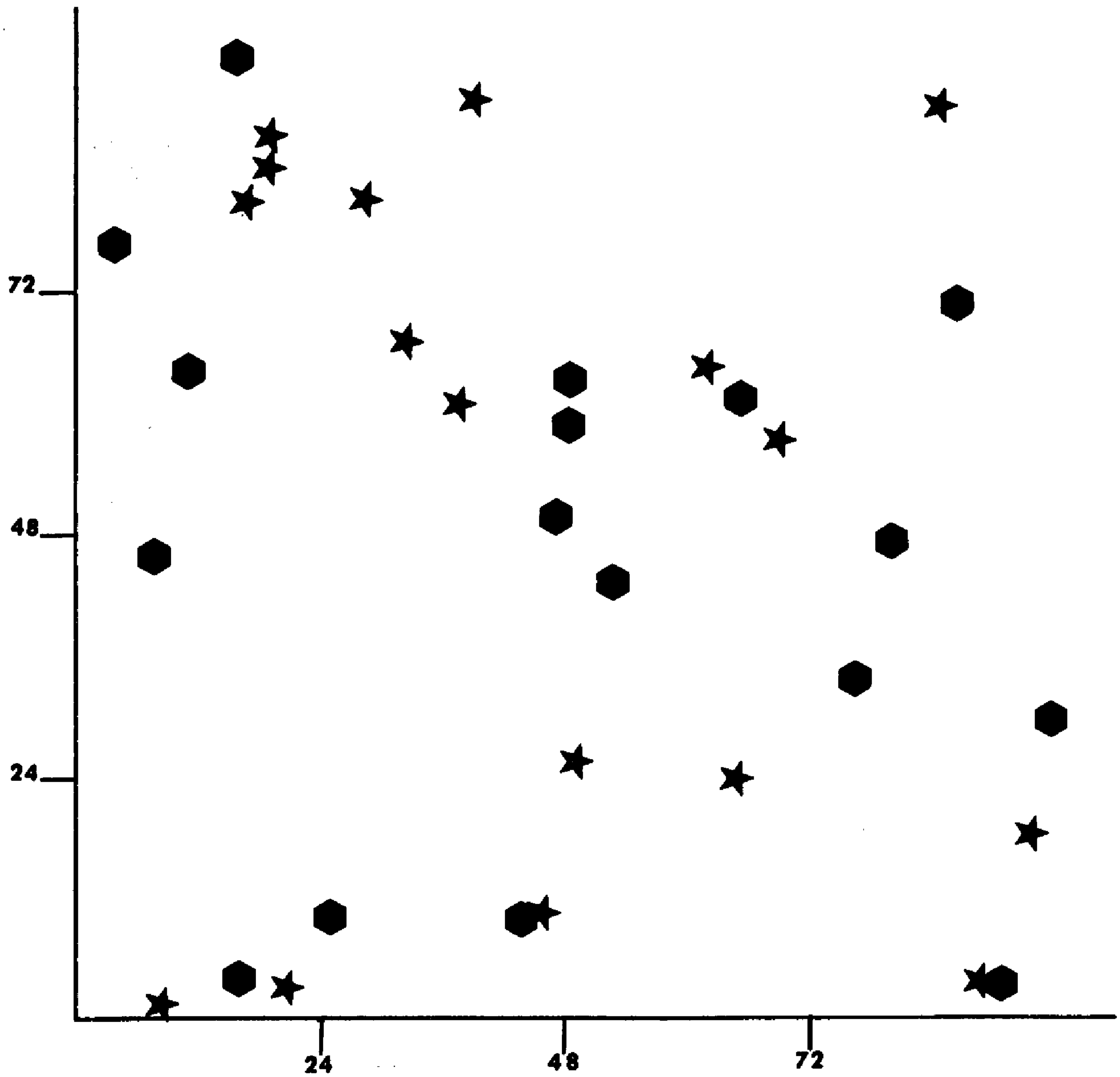

Fig. 115. Random Points Test No. 4.

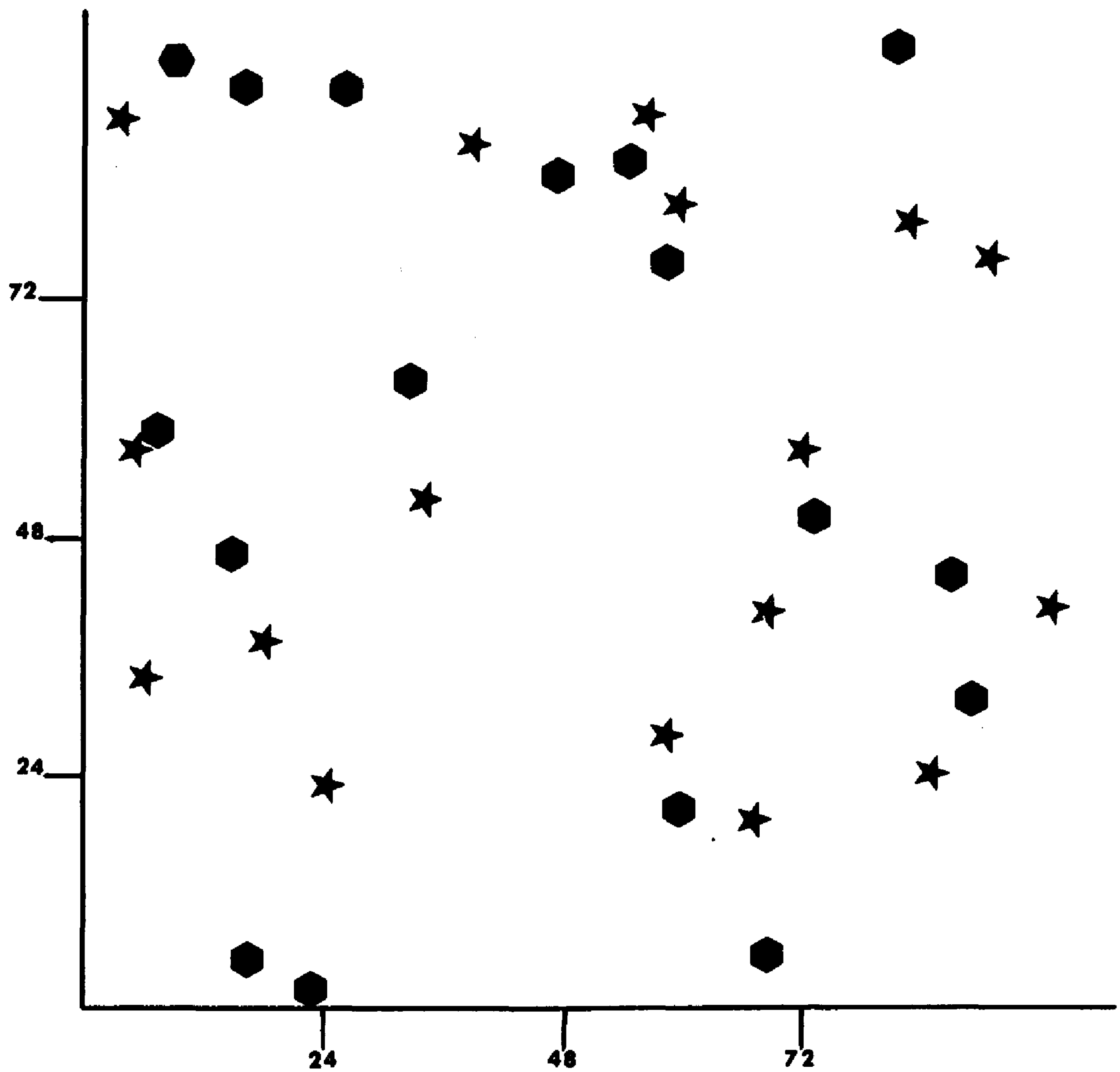

Fig. 116. Random Points Test No. 5.

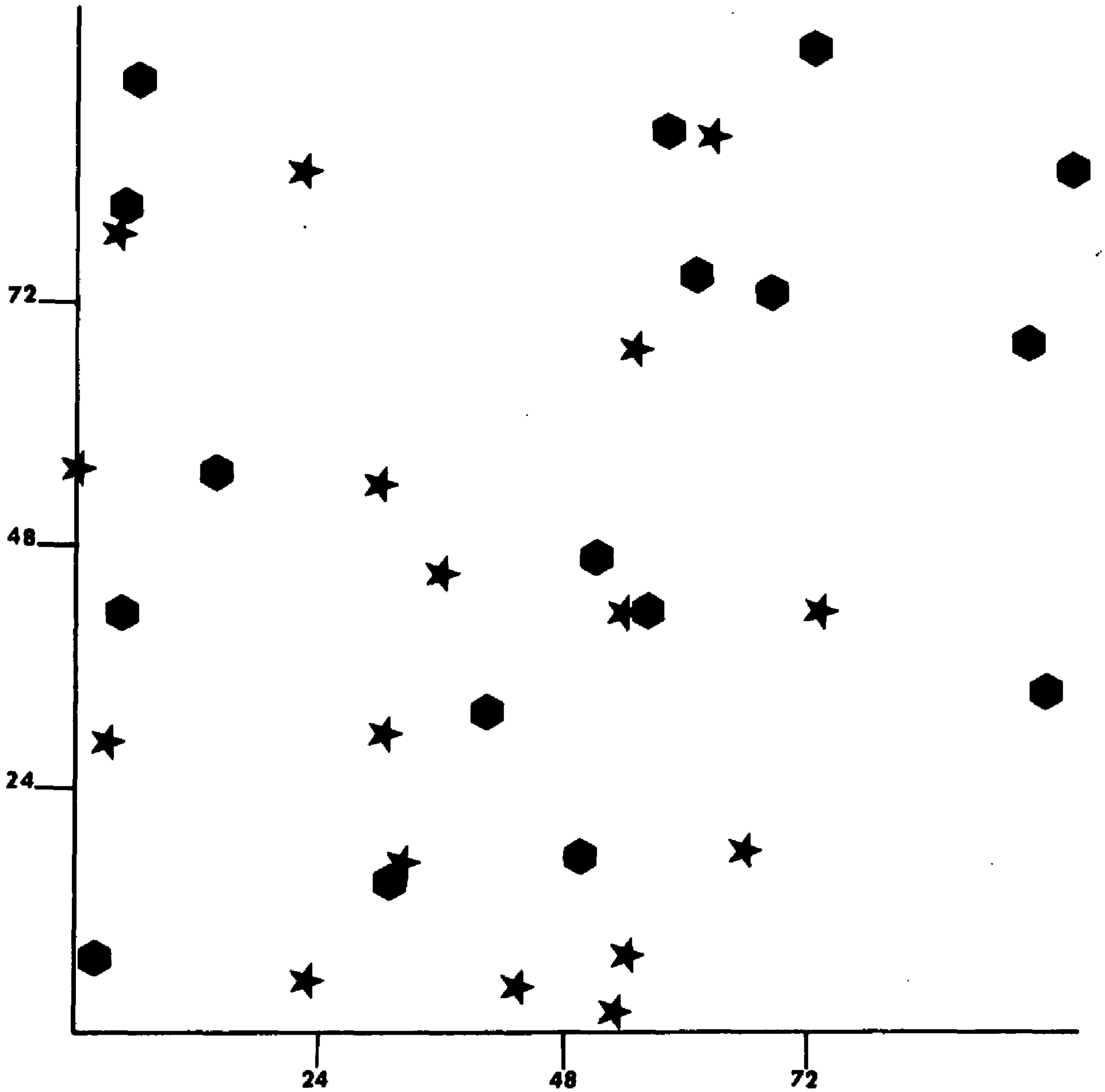

Fig. 117. Random Points Test No. 6.

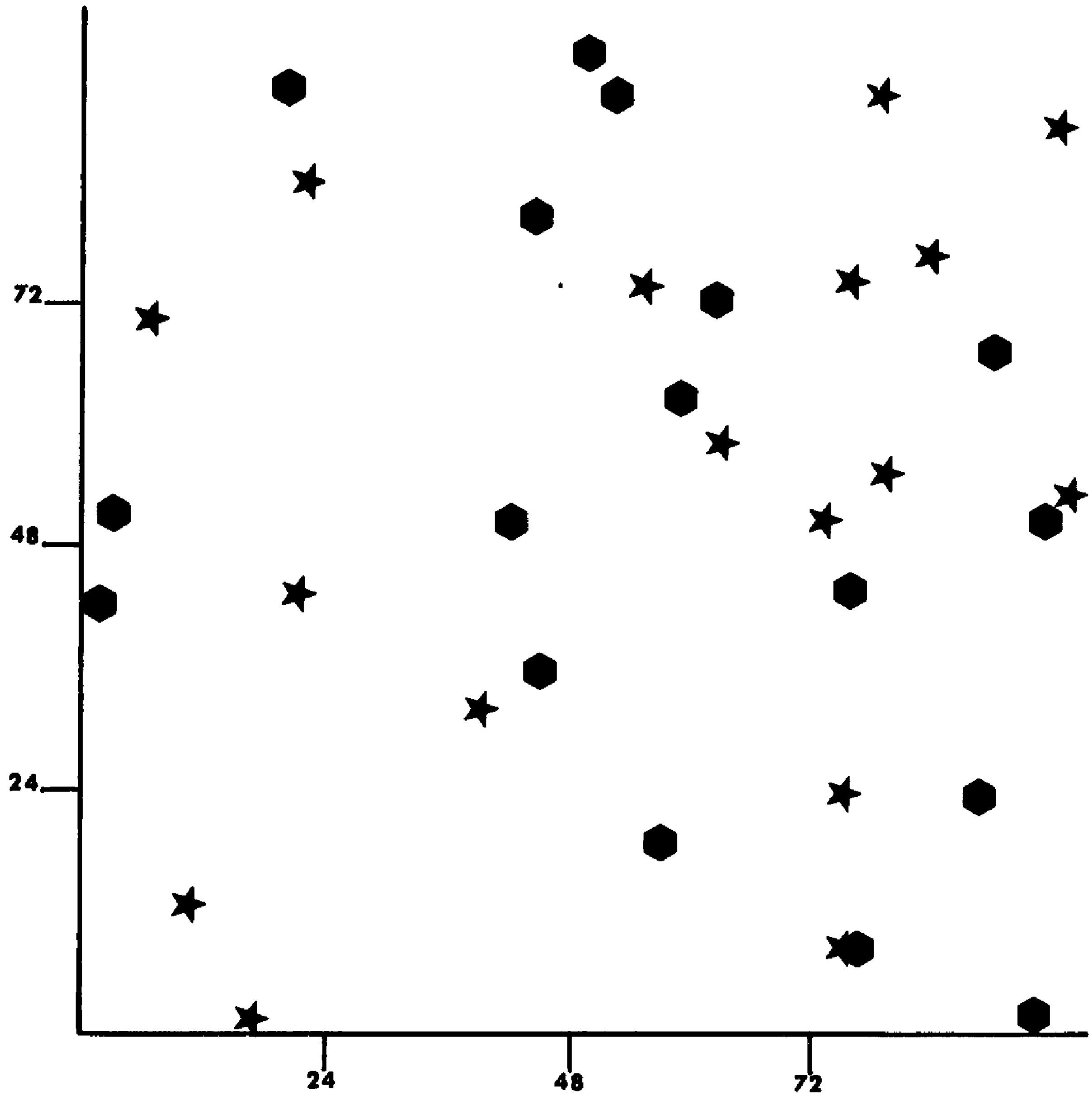

Fig. 118. Random Points Test No. 7.

APPENDIX E

PRINCIPAL COMPONENTS DATA FOR TYPE 3 VESSELS

TABLE 63

TYPE 3 VESSELS: HOUSES 21 AND 89
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	6.39466	63.9	63.9
2	2.32358	23.2	87.2
3	.86124	8.6	95.8

TABLE 64

TYPE 3 VESSELS: HOUSES 21 AND 89
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.54804	.68036	.34296
2	.63783	.62832	.37084
3	.69440	.68189	-.03631
4	.71599	.51806	.41344
5	.85963	.04317	-.46487
6	.92392	-.24196	-.23141
7	.92796	-.34611	-.03994
8	.90071	-.41483	.09657
9	.85866	-.44739	.22806
10	.83091	-.42439	.31822

TABLE 65

TYPE 3 VESSELS: HOUSES 21 AND 90
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	6.93188	69.3	69.3
2	1.88237	18.8	88.1
3	.78001	7.8	95.9

TABLE 66

TYPE 3 VESSELS: HOUSES 21 AND 90
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.68719	.58482	.25638
2	.72064	.59831	.27328
3	.76861	.58871	.03156
4	.80358	.40873	-.35745
5	.85421	-.01055	-.49860
6	.91031	-.26603	-.25545
7	.92999	-.33534	-.06783
8	.90140	-.40584	.11362
9	.86253	-.42486	.26052
10	.85098	-.37445	.33406

TABLE 67

TYPE 3 VESSELS: HOUSES 89 AND 90
EIGEN VALUE AND PERCENTAGE OF VARIANCE
FOR EACH COMPONENT

Component	Eigen Value	Percentage of Variance	Cumulative Percentage
1	6.62042	66.2	66.2
2	1.97378	19.7	85.9
3	.89491	8.9	94.9

TABLE 68

TYPE 3 VESSELS: HOUSES 89 AND 90
LOADINGS ON EACH ORIGINAL VARIABLE

Variable	Component 1	Component 2	Component 3
1	.48049	.70197	.39654
2	.66709	.63320	.24253
3	.74003	.60862	-.02825
4	.75327	.36405	-.47736
5	.85778	-.03226	-.47371
6	.93975	-.17083	-.20431
7	.95221	-.27341	.00507
8	.91852	-.35520	.15349
9	.87451	-.40021	.25440
10	.83392	-.43108	.30859

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